AN ECONOMIC ANALYSIS OF RICE FARMING IN THREE SELECTED MUNICIPALITIES OF LAGUNA, PHILIPPINES, 1966 to 1971

by

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DECLARATION

Except where otherwise indicated, this sub-thesis is my own work.

July, 1974 V.G. Cordova

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ABSTRACT

This study was conducted mainly to obtain information regarding (1) the relationship of the factors of production such as (a) rice variety, (b) amount of fertilizer, insecticide and other inputs used by the farmers, (c) adequacy and reliability of the farmer's water supply, and (d) natural disasters on rice yields; and (2) the efficiency of resource use and potential for increasing productivity through resource adjustment under the existing technology.

The municipalities of Biñan, Cabuyao, and Calamba in the province of Laguna, Philippines were selected as the study areas.

The findings suggest that with adequate water supply, use of new rice varieties and additional operating costs of inputs could have a substantial impact in increasing rice yield. Under the existing technology, however, there is little potential for increasing rice production. There is a possibility of achieving higher rice yields through adjustment of some resources and cultural practices, and adoption of new varieties of rice. But farmers will adjust their use of resources and adopt new rice varieties and practices only if policy makers will direct their policies at reducing risk and uncertainty in rice farming through better supportive services, in order to create conditions which will provide sufficient incentives and inducements to farmers to invest in the future.

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CHAPTER I

INTRODUCTION

1.1 The Problems

In the six years since their introduction, the new 'miracle' varieties of rice have come to be seen as a major breakthrough in rice production, not only in the Philippines, but also for most of the Asian rice producing countries.

However, in spite of this success story in rice breeding, the Philippines' rice yield is still lagging far behind the yield in most Asian countries and in the world as a whole. In 1972 it averaged 1.5 tonnes of rough (unmilled) rice per hectare and had increased relatively little over the preceeding six years.

TABLE 1

COMPARISON OF ROUGH RICE YIELD BY SELECTED COUNTRIES, 1966-1972

Selected Countries	1966	1967	1968	1969	1970	1971	1972	Average 1966-1972
	(tonne/ha)							
Japan	5.1	5.7	5.7	5.6	5.6	5.2	5.8	5.5
Rep. of Korea	4.4	4.1	3.9	4.7	4.6	4.6	4.6	4.4
China	2.9	2.9	2.9	2.9	3.1	3.1	3.1	3.0
Indonesia	1.8	1.8	1.9	1.9	2.4	2.4	2.4	2.1
Thailand	2.0	1.8	1.9	1.9	2.0	2.0	1.8	1.9
Burma	1.5	1.7	1.7	1.7	1.7	1.7	1.6	1.6
Philippines	1.3	1.4	1.3	1.7	1.7	1.6	1.5	1.5
	(1.3)	(1.3)	(1.4)	(1.3)	(1.7)	(1.7)	(1.6)	(1.5)
Asia	2.8	2.8	2.8	2.9	3.0	3.1	3.0	2.9
World	2.0	2.2	2.2	2.2	2.3	2.3	2.3	2.2

Source: FAO, Production Yearbook, Vol 26, 1972.

Figures enclosed in parentheses, under Philippines, are obtained from the Bureau of Agricultural Economics, Philippines.

Because of this low productivity, the Philippine Government had to import rice in order to feed its growing population, which is increasing at the rate of 3.02 per cent annually.

During a six-year period, total production had actually increased, though somewhat erratically, from nearly 2.2 million tonnes in 1966 to about 2.7 million tonnes in 1971 (Table 2). The increase in production had mostly been accounted for by increase in yield. Yield contributed an increased of significantly 23 per cent while since the area harvested increased by only 4 per cent for this period (1966 to 1971).

TABLE 2

PRODUCTION, AREA HARVESTED, CONSUMPTION, IMPORTS, (QUANTITY AND VALUE) OF CLEAN (MILLED) RICE AND PROPORTION OF IMPORTS TO TOTAL CONSUMPTION, PHILIPPINES, 1966-1971

Year	Production[a]	Area harvested[a]	Consumption[b] (estimated)	Imports[c]		Imports as a proportion of consumption
				Quantity	Value	
	('000 tonnes)	('000 ha)	('000 tonnes)	('000 t)	('000 Pesos)	%
1966	2158	3110	2988	108	53,800	3.6
1967	2170	3100	3088	291	165,008	9.4
1968	2417	3300	3207	8.4	11.6	0.3
1969	2356	3110	3614	9.5	13.3	0.3
1970	2774	3110	3818	0.39	0.32	0.01
1971	2703	3230	n.a.	370	202,728	n.a.

Sources: a. Bureau of Agricultural Economics, Philippines. Conversion of rough rice (unmilled) to clean rice (milled) based on the milling recovery of 53 per cent (1966-1970).

b. National Economic Council, Philippines (1966-1970).

c. Foreign Trade Statistics, Bureau of Census and Statistics, Philippines (1966-1971).

n.a. Not available.

Significant imports were made in 1966, 1967 and 1971, to keep up with the consumption which had been increasing steadily. No imports were reported from 1968 to 1970, although the relatively small quantities indicated in the table are most likely to be residual shipments due to purchase orders of previous years. It is interesting to note the tremendous increase in the proportion of imports in terms of consumption from 1970 to 1971. Increase of imports in that period was relatively high due to the fact that a number of typhoons passed the country in the latter part of 1970.

If we add imports and domestic supplies of rice, the total does not seem to sustain the estimated rice consumption of the country. It is worthwhile mentioning here, that according to the report of the Inter-agency Committee on Rice and Corn Production and Comsumption, the records of the estimates of the crop year-end stocks in comparison with actual reported stocks for crop years 1966 to 1971 have indicated an average aggregate error of less than 3 per cent of production over the last five years.

Realizing this grave problem of low productivity, the present administration has embarked on a program to attain self-sufficiency in rice. Before any program aimed at improving the productivity of rice growing can be formulated, the research worker must not only know the factors that cause low productivity but must also be able to suggest measures to solve the problems in order to achieve the desired goal of self-sufficiency.

Circumstances that lead to low productivity in rice are not only intricate but are also interconnected in nature. Some of these are:

(1) institutional factors, i.e. tenancy problems and lack of credit to meet the needs of the poor farmers;

(2) absence of requirements of production such as improved rice varieties, fertilizer, insecticides, pesticides, weedicides, and irrigation;

(3) the environmental factors, i.e. rainfall, solar energy and the occurrence of typhoons; and

(4) inefficient use of existing resources.

Factors (1), (2) and (4) may easily be controlled by man through individual or group effort, while (3) is difficult to control.

The effect of social factors, although considered to be important in explaining the low productivity in rice, will not be treated in this study. The reasons are that most of the sample farmers were share tenants, making it difficult to compare productivity according to tenure status and that information on credit was not included in the survey schedule.

This study focuses on the problems of absence of requirements of production, environmental factors and inefficient use of resources.

1.2 Review of Literature

Beachell (1970) suggests that the low yields in the tropics are the net result of many factors, over and above the generally poor cultural management: inadequate water control, insufficient protection against pests and adverse environmental conditions during the wet season, the lack of non-lodging, nitrogen responsive and potentially high-yielding varieties of rice is the primary causative factor.

The indica varieties grown in the Philippines such as Peta, Intan, BE-3 and Raminad, which are native to the tropics, are generally tall (in excess of 150 cm), late-maturing, photo-period sensitive, leafy, profuse tillering and susceptible to lodging. The fact that the typical rice crop lodges before maturity and sometime before flowering, contributes to the relatively low yields in the Philippines. Lodging also lowers the quality of the grain (Beachell and Jennings, 1964).

Recently rice breeders have been successful in developing nitrogen-responsive rice varieties from traditional tropical indica varieties by introducing genes for short stature, sturdy stems, erect growing line of moderate length, early maturing (110 to 140 days), and photo-period insensitivity; if properly managed these varieties could produce yields of 5 to 6 tonnes per hectare during the monsoon season, a dramatic increase from the national average yield of approximately 1.5 tonnes per hectare.

Related closely to the problem of rice variety is the effect of the amount of fertilizer used in increasing rice production. Experiments conducted at IRRI during the 1967 wet season showed the effect of nitrogen levels on the grain yield of rice varieties. IR8, the earliest of the new varieties introduced by IRRI, showed an increase of yield from 3.3 tonnes/ha for 0 nitrogen application to 5.3 tonnes/ha for 80 kg/ha of nitrogen application, a yield increase of almost 60 per cent.

Another major factor that causes low yield in the Philippines is the insect, disease and pest damage. Most rice is grown in the warm and humid tropics. Unfortunately, tropical conditions also favour the proliferation of insects, diseases and other pests of rice.

Pathak (1970) reported the extent of destruction caused by insects in 24 separate experiments conducted at IRRI in six cropping seasons. In these tests, plots protected from insects yielded an average of 5.3 tonnes per hectare and the unprotected plots averaged 2.9 tonnes per hectare. In these tests, therefore, insect control increased yield by about 80 per cent.

One of the major agricultural pests in the Philippines is the rice-field rat. It damages rice in all its growth stages from germination to panicle-b bearing. Alfonso, et.al. (1970) reported that the value of damage caused by rats to the rice crop before harvest in 1958 was estimated by the Bureau of Plant Industry, Philippines, at about 40 million pesos. This estimate is based on the average damage of 0.22 tonnes per hectare (out of the national yield average of 1.02 tonnes per hectare) in 600,000 hectares of infested rice, at a cost of 16 pesos per cavan of 44 kilograms.

De Datta (1970) reported the seasonal effects of physical environment on rice yield. Variability in the amount and distribution of rainfall often causes severe reduction in grain yield of rice. Figures published by the Bureau of Agricultural Economics, Philippines (1971) showed that the yield of rice in the irrigated area is much higher than that of the rainfed-lowland area. The yield in the irrigated lowland is 1.99 tonnes per hectare (average wet and dry season) while that of the rain-fed lowland is 1160 tonnes per hectare, a difference of about 25 per cent. In many rice growing areas, the year is divided into fairly distinct wet and dry seasons. In most areas, the bulk of rice produced comes from the wet season harvests. A small amount of rainfall is received during the dry season which is insufficient to grow a crop of rice. Hence, a dry season crop is grown under irrigation. Due to lack of adequate irrigation facilities in most rice growing areas production in the dry season is limited.

If irrigation water is available, rice can be grown in the dry season and grain yield obtained will be higher than in the wet season. The planting date can be adjusted so that maximum solar energy can be received by the crop during the reproductive stage. Recent results from IRRI showed that total solar energy for 30 to 45 days before harvest of three indica varieties was highly correlated with grain yield. Table 3 shows how closely related is the grain yield of rice with the solar radiation 30 to 45 days before harvest.

In connection with the effect of solar energy on rice yield, De Datta (1968) showed how nitrogen responses of 4 varieties vary with the amount of solar energy received during the 45 days before harvest. Nitrogen response (the increase in grain yield with added nitrogen) of a variety decreased as the amount of solar energy decreased during the last 45 days before harvest (Fig. 1).

FIGURE 1

NITROGEN RESPONSE OF 4 VARIETIES AS AFFECTED BY MONTH OF HARVEST, DATE OF PLANTING EXPERIMENT, IRRI, 1968, (S.K. DE DATTA, IRRI SATURDAY SEMINAR, SEPTEMBER 28, 1968)

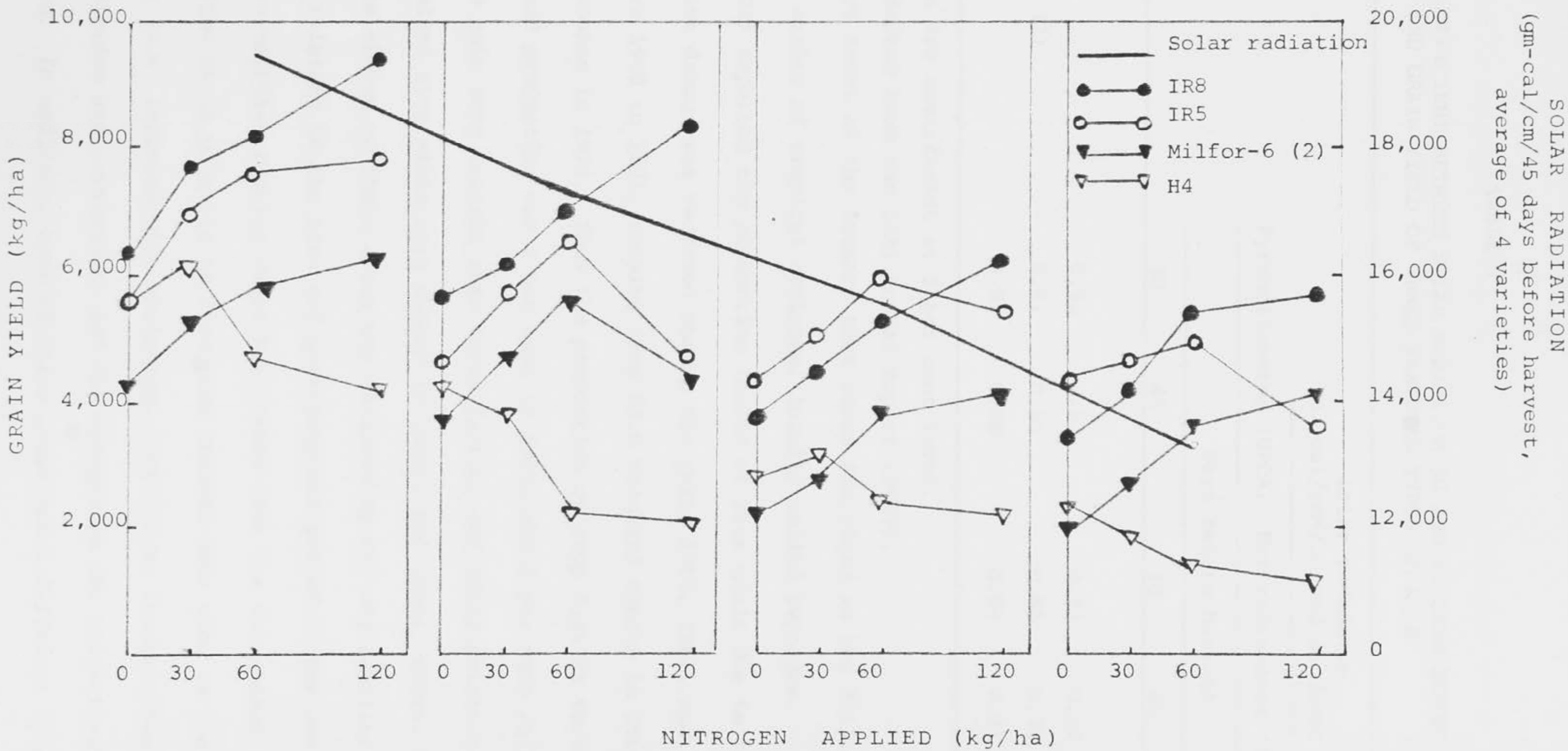

TABLE 3

CORRELATION COEFFICIENT BETWEEN SOLAR RADIATION 30 AND 45 DAYS BEFORE HARVEST AND GRAIN YIELD OF THREE VARIETAL TYPES OF RICE

	Solar radiation ($g. cal/cm^2/30$ and 45 days)			
	Pyrcheliometer (UPCA)		Net radiometer (IRRI)	
	Days before harvest			
	30	45	30	45
Variety				
IR8	0.92	0.93	0.77	0.82
Milfor - 6 (2)	0.81	0.85	0.66	0.78
H - 4	0.85	0.86	0.84	0.91

All coefficients are significant at 5 per cent level.

Source: Table adapted from the IRRI Annual Report (1967).

Last but not least of the factors that cause low yield in the Philippines is the frequent visits of tropical cyclones, locally called typhoons.

Canlas (1973) reported the production losses of rice grain due to typhoons. The most extensive damage was recorded during the years 1963, 1965, and the consecutive years 1968 to 1971, ranging from 83.6 thousand tonnes in 1965 to 470.8 thousand tonnes in 1971. Thus the proportion of crop lost in terms of the total expected production was 2 per cent in 1965, and 8 per cent in 1971.

In order to gain some insight into these factors and their relation to yield, three lowland rice areas were chosen in Laguna province: Binan, Cabuyao, and Calamba. The choice of these areas was dictated by the availability of comparable data relating to the pre- and post-adoption period of the new rice variety. The pre-adoption records cover the period from the wet season in 1966, through 1971. Thus it is possible to study the changes over time in the use of factor inputs (i.e. improved rice varieties, fertilizer, insecticides, pesticides, weedicides and irrigation) and the changes in the productivity flowing thereform. In addition, each of these areas has a different type of irrigation, making it possible to study the relationship between irrigation, adoption pattern of the improved rice variety, farm practices and productivity.

Information and reports on crop damage by typhoon, insects, drought and pests were incorporated only in the 1970 analysis. This will give us the opportunity to examine the effects of environment on rice productivity. The period (1970 wet and dry season) was chosen because this was the only period for which complete information on weather and crop damage was available.

1.3 Objectives and Hypotheses

The general objective of the study is to determine the changes in the use of resource inputs, in productivity of rice farms, and in the pattern of adoption of high-yielding varieties from 1966 to 1971. A detailed examination of the factors that might explain variability in rice yield is made for the 1970 wet and dry season period, using cross-sectional data.

The ultimate objective is to help attain greater rice productivity in these three rice farming areas.

The specific objective of the study is to test the hypotheses that:

(1) Yield was substantially influenced by the factors of (a) rice variety, (b) the amount of fertilizer, insecticide and other inputs used by the farmers, (c) the adequacy and reliability of the farmer's water supply, and (d) natural disasters or 'acts of God'.

(2) Agriculutral resources are being inefficiently utilized, thus causing low productivity in the use of resources.

With the existing technology, the possibility of increasing yield will be explored by the method of partial budgeting.

1.4 The Organization of the Sub-thesis

This sub-thesis is apportioned into six chapters.

Chapter 1 deals with the problem, objectives and hypotheses of the study.

Chapter 2 presents the research methodology which includes the setting of the study, data collection, definitions and abbreviations of the variables used and the analytical framework for testing the hypotheses.

Chapter 3 gives a description of the farms, covering size of farm holdings, type of irrigation, double cropping intensity, variety planted, farming practices and net farm income. This description provides a reference point for the analysis to follow.

Chapter 4 is concerned with the analysis of rice yield. The relationship between rice yield and adoption of rice variety as well as other factors are analyzed by means of production function analysis.

Chapter 5 discusses the analysis of resource productivity. This analysis shows how agricultural resources are being efficiently utilized in the three selected rice areas. The Cobb-Douglas type of production function is used to determine the resource productivity.

Partial budgeting is also presented in this chapter. This particular economic technique aids agricultural scientists in determining the benefit that could be derived from a particular innovation being introduced to farmers.

Chapter 6 gives the conclusions of the study.

CHAPTER 2

RESEARCH METHODOLOGY

2.1 The Setting and Data Collection

A study of rice farming in three selected municipalities in Laguna in the Southern Tagalog region of the Philippines was undertaken by Liao (1966-67) to gain some information on the production, revenues and costs, and adoption of new rice varieties by 155 rice farmers. Subsequent surveys were done annually (from 1968 to 1971), after the wet and dry season harvests, in order to look into the pattern of adoption of high-yielding rice varieties, production, costs and returns and farming practices in the area.

The results of the 1966 to 1969 surveys have already been reported.[1]

The general discussion of this study is thus focused on the surveys conducted in the wet and dry seasons of 1970. However, some results of the 1966 to 1969 and 1971 surveys are also presented for the purpose of showing the changes from 1966 to 1971.

2.2 The Setting

Laguna Province (Figure 2) extends over a total land area of 175,970 hectares. It is composed of 29 municipalities. The province is situated in the Southern Tagalog Region. It is bounded on the north by Laguna de Bay, on the south by Batangas, on the west by Cavite and on the east by Quezon.

The terrain of Laguna consists mainly of low flat plains with elevations toward the north-eastern portion. The province has three types of climate,

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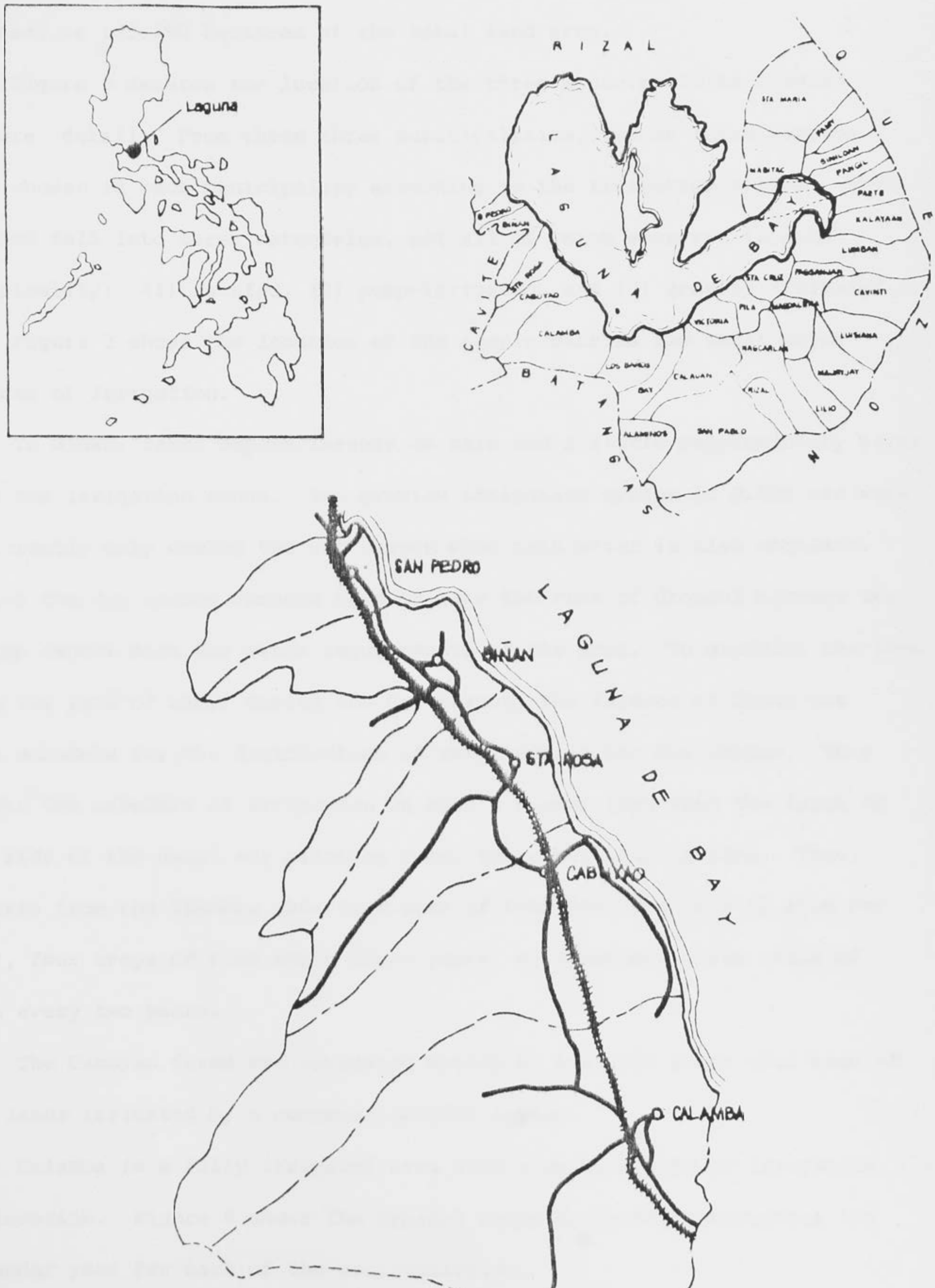
1. A detailed report of the 1966 survey was reported by Liao (1968). The changes in rice farming from 1966 to 1969 were reported by IRRI (1970) and by Barker and Cordova (1971).

FIGURE 2

MAPS SHOWING THE MUNICIPALITIES OF BIÑAN, CABUYAO, AND CALAMBA, IN THE PROVINCE OF LAGUNA, PHILIPPINES



and is not spared from the cyclonic storms and depressions that pass over the country.

Cultivated land in Laguna Province is widespread, occupying 77.02 per cent or 135,790 hectares of the total land area.

Figure 3 denotes the location of the three municipalities studied in more detail. From these three municipalities, two or three barrios were chosen in each municipality according to the irrigation system. Areas studied fell into three categories, not all of which occurred in each municipality: (1) rainfed, (2) pump-irrigated, and (3) gravity irrigated.

Figure 3 shows the location of the sample barrios and their major sources of irrigation.

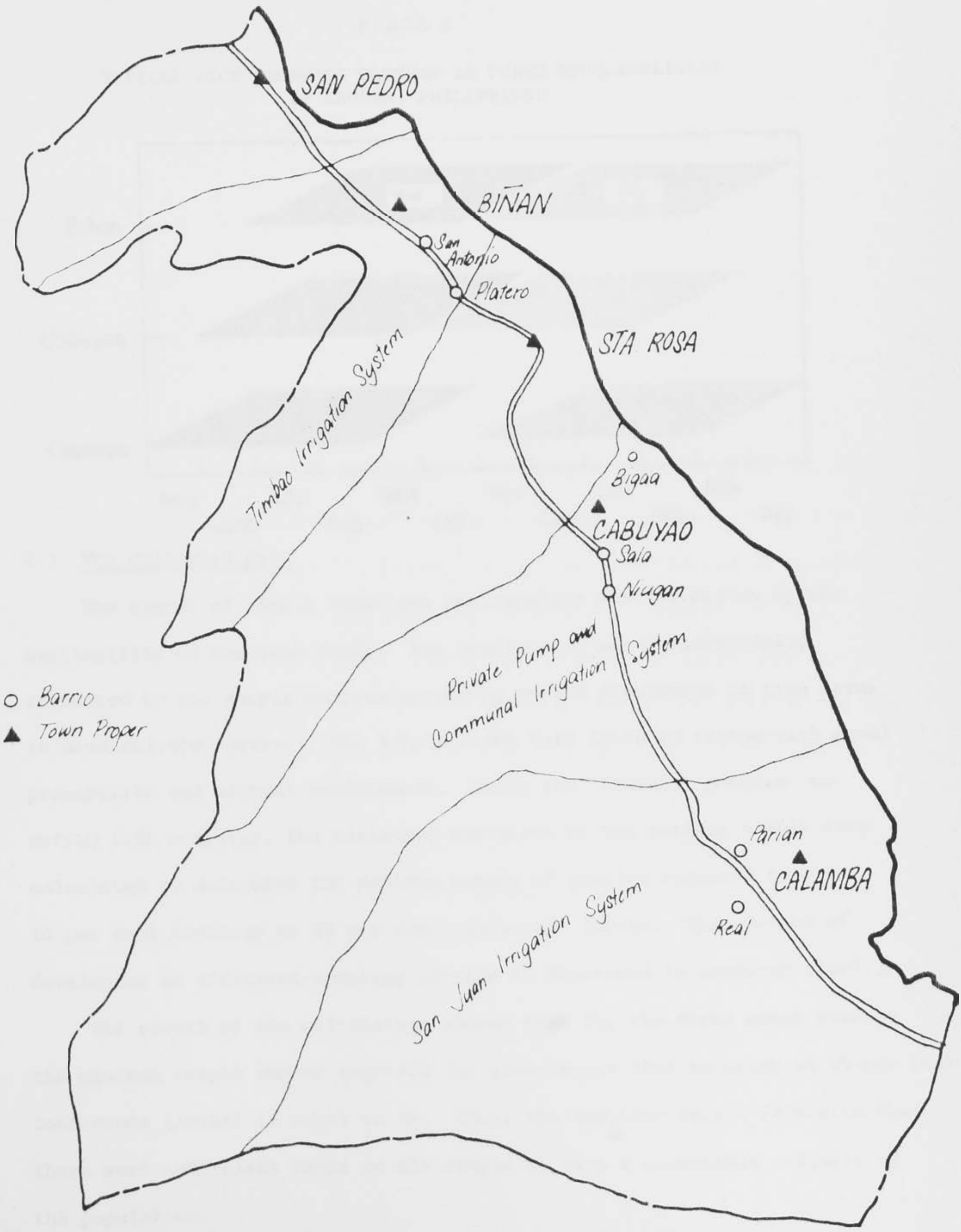
In Biñan, farms depend largely on rain and a little supplementary water from the irrigation canal. The gravity irrigation system in Biñan can work efficiently only during the wet season when rain water is also abundant. During the dry season farmers have to face the risk of drought because the system cannot meet the water requriements of the area. To minimize the loss from the lack of water during the dry season, the farmers in Binan put up a schedule for the distribution of water during the dry season. They rotate the schedule of irrigation in such a manner that when the farms on one side of the canal are planting rice, the other side is idle. Thus, reports from the farmers show that some of them have one crop of rice per year, four crops of rice every three years, or sometimes three crops of rice every two years.

The Cabuyao farms are irrigated mostly by low-lift pumps with some of the lands irrigated by a communal gravity system.

Calamba is a fully irrigated area with a gravity type of irrigation by location. Figure 4 shows the typical cropping pattern throughout the calendar year for each of the municipalities.

FIGURE 3

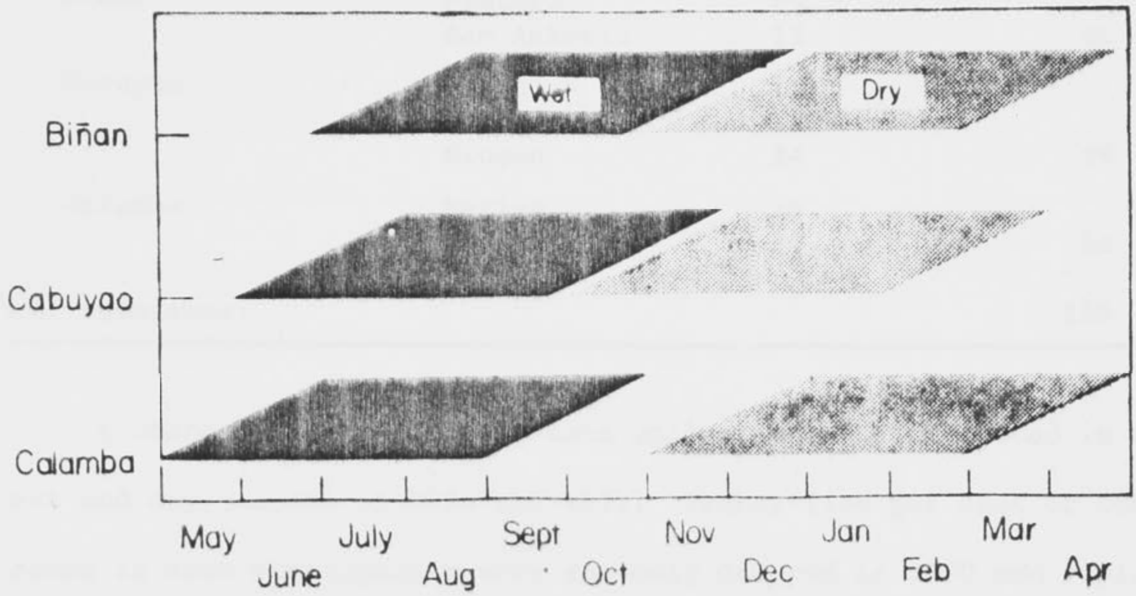
MAP SHOWING LOCATION OF SAMPLE BARRIOS AND THE MAJOR SOURCES OF IRRIGATION IN BIÑAN, CABUYAO, AND CALAMBA, LAGUNA, PHILIPPINES



As mentioned earlier, differences in the cropping pattern among the study areas would appear to be due principally to the water resource situation.

FIGURE 4

TYPICAL RICE CROPPING PATTERN IN THREE MUNICIPALITIES OF LAGUNA, PHILIPPINES



2.3 The Collected Data

The number of sample farms per municipality was decided on by the availability of research funds. The sample size was proportionally allocated to the sample barrios according to the population of rice farms in each selected barrio. The sample farms were drawn at random with equal probability and without replacement. Using the 'BASTATS' program on UNIVAC 1108 computer, the variances and means of the current sample were calculated to determine the minimum number of samples required to give 10 per cent accuracy at 95 per cent confidence limits. This method of developing an efficient sampling program is described in Snedecor (1967).

The result of the calculation showed that for the three areas studies the minimum sample number required (to give 10 per cent accuracy at 95 per cent confidence limits) is equal to 48. Thus, the computer result indicates that there were sufficient farms in the sample to give a reasonable estimate of the population.

The number of farms surveyed in each area is shown in Table 4.

TABLE 4

THE SETTING OF THE STUDY AND THE NUMBER OF FARMS SURVEYED, LAGUNA, PHILIPPINES, 1970

Municipality	Barrios	No. of farms	Total
Biñan	Platero	29	
	San Antonio	12	40
Cabuyao	Bigaa	14	
	Sala	21	
	Niugan	24	59
Calamba	Parian	35	
	Real	20	55
All locations:			155

A change in the method of data collection was introduced in the wet and dry seasons of 1970 and 1971. Twenty-five per cent of the sample farms in each municipality were randomly dropped in 1970 and replaced by new farmers in the area. A further 25 per cent (not including farmers newly selected in 1970) were randomly dropped and replaced in 1971. This replacement of the old sample farmers was done on the assumption that when a research worker comes into contact always with the same farmers, he may be giving information that might greatly influence the decision-making process of the farm operator.

The method used in collecting the data was through personal interviews with the sample farm operator. The interview was scheduled just after the crop harvest in order that the farmer's memory of his activities on the farm for that season would still be fresh.

The interview schedule used varied each year according to the immediate needs of the research worker. However, it was always decided to include information on area planted, type of irrigation, tenure status, variety planted, production price of rice received by the farmer, kind and amount of fertilizer used, and amount of insecticide and weedicide used.

The 1966 survey schedule which Liao (1968) used for his Master's thesis included the following information:

a. Crop information - this includes data on area planted, type of irrigation, tenure status, variety planted, production, and price of rice received by farmer;

b. Labour inputs for each farm practice (hired, family, exchange and operator labour);

c. Cash expenses for each farm practice (e.g. fertilizer, insecticide and weedicide costs).

d. Inventory of land, buildings, tools, equipment and supplies;

e. Farm practices adopted by rice farmers (e.g. dapog or wetbed method of growing rice seedlings), and their reasons for the adoption or rejection of improved practices;

f. Demographic, social, and economic characteristics (e.g. age, educational attainment, number of dependents, number of years farming in the barrio, occupation, off-farm income, etc); and

g. The extent of assistance received from the government.

The 1967 to 1969 and 1971 survey schedules included the following information:

a. Crop information - (the same as the 1966 survey schedule; additional information on the date of planting and date of harvest was however incorporated in the 1969 and 1971 survey);

b. Cash expenses for each farm practice (the same as in the 1966 survey schedule).

The 1970 survey included the same questions as before with the exception that it excluded the questions regarding reasons for the adoption or rejection of improved practices by the farmer, and included questions on the method of sharing of farm expenses among tenanted farmers and supplementary information, such as reports on crop damage. Information on solar energy and rainfall for the 1970 wet and dry seasons was obtained from the IRRI and at the UP College of Agriculture in Laguna, where the measuring devices are situated.

From the recorded information, the individual farm observations on solar energy and rainfall were calculated. The solar energy observation for each farm was obtained by adding the daily values of solar energy from 45 days before harvest to harvest time. The date of harvest was obtained through the personal interview of each farmer operator.

The individual rainfall observation for each farm was obtained by adding the daily values of rainfall from the time of planting to the time of harvest. Again, the dates of planting and harvesting were obtained from the farmer operator through personal interview.

Information on solar energy and rainfall is taken into account in the regression analysis of rice yield in Chapter 4.

Land value of rice land by type of irrigation was also secured from the Assessor's Office of the Provincial Capital of Laguna. The land value is used in the analysis of resource productivity in Chapter 5.

2.4 Definitions of Terms Used

Rice variety is divided into two categories: local and new varieties.

Local varieties as referred to here are rice varieties traditionally planted by farmers and normally with low-yielding capability.

New varieties include those rice varieties that were officially introduced by the IRRI, UP College of Agriculture and Bureau of Plant Industry and finally approved and recommended by the Philippine Seed Board for commercial planting due to their proven high-yielding capacity.

Types of Adopters: Full adopters are farms planted wholly to new varieties; partial adopters are farms planted to new and local varieties; and non adopters are farms planted wholly to local varieties.

Quality of irrigation is either 'poor' or 'good'. Where irrigation is poor, farms are irrigated by rain or irrigated once a year, thrice every two years, or four times every three years by gravity or by pump. Lumping these farms into poor irrigation seems warranted, although there seems to be a wide range in irrigation qualities among farms, since they fall outside the definition of good irrigation. Areas with good irrigation are farms which have sufficient water to grow two or more crops of rice in a year.

Gross revenue is the total production multiplied by the price of rice received by the farmer during a particular production period.

Gross farm income is defined as the total revenue from producing rice during the whole year.

Operating costs are those which vary with the quantity of production, consisting of hired labour, fertilizer, insecticides, weedicides, seeds, etc.

Net income is measured as the gross revenue less operating costs, during a particular production period.

2.5 Analytical Framework for Testing Hypothesis

The farm survey data were first grouped according to the study area and secondly according to the type of adopter. These groupings provided a measure of the gross income for the different farm situation in the three areas studied. The results may be seen in Chapter 3.

The survey data were then used in conducting production function analysis or rice yield by the statistical procedure of ordinary least square. The UNIVAC 1108 computer was used to calculate the function by the Program OLS. The results of the analysis of rice yield may be seen in Chapter 4.

The production function was again used to permit the testing of the marginal value productivity of resources under the prevailing situation. Results and discussions on marginal value productivity of resources may be seen in Chapter 5.

2.6 Analysis of Rice Yield

Hypothesis (1) of this thesis (section 1.3) may be stated formally as follows: Yield was substantially influenced by the factors of (a) rice variety, (b) amount of fertilizer, insecticide and other inputs, (c) quality of irrigation, and (d) natural disasters or "acts of God" (e.g. typhoons, flooding, drought or insect infestation). The hypothesis was tested on the basis of production function analysis. The production function as used here is the functional relationship between resource inputs and product output.

The model used for this investigation was a power function of the Cobb-Douglas form. Although the Cobb-Douglas function has advantages and disadvantages for analysing farm data, its widespread use in studies of this kind is due to its conformance to economic theory and the ease of statistical computation.[2] In addition, the function, which is linear in logarithms, is commonly used in productivity estimates because the estimated coefficients (excepting the intercept) are elasticities (Ep)[3] and with these it is easy to determine the marginal productivity (MP) of the resources or inputs.

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2. Heady (1952, pp. 775-786).

3. That the exponents are the elasticities of production is proved. Taking a single-variable power function, then

$$Y = a\,x^{b} \qquad (3)$$

Where Y is the output, x is the variable resource measured, a is the log intercept, and b is the exponent coefficient.

The marginal product (MP) is:

$$MP = \frac{\partial Y}{\partial x} = b\,a\,x^{b-1} \qquad (4)$$

The elasticity of production is:

$$Ep = \frac{dY}{dx} \cdot \frac{x}{Y} = b\,a\,x^{b-1} \cdot \frac{x}{y} \qquad (5)$$

Parish and Dillon,[4] and Jarrett[5] have commented on the problems associated with the use of Cobb-Douglas form for analysis of farm data, particularly with regard to economic and statistical specification.

Plaxico,[6] however, suggested that if farms were using essentially similar production techniques and producing the same product, then the function can provide a legitimate basis for farm planning.

The Cobb-Douglas function, with more than one variable resource, is of the form of the following equation:

$$Y = aX_1^{b_1} \; X_2^{b_2} \; \ldots . Xn^{b_n} \; E_i \qquad (1)$$

Where Y refers to the output, X_1 to X_n are the variable resources measured, a is a constant, and b_1 to b_n are coefficients that define the transformation ratio when X_1 to X_n are at different magnitudes and E_i is the error term.

The function is linear in logarithms:

$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 \ldots . b_n \log X_2 + \log E_i$ and hence it is easy to fit by linear regression techniques.

In the analysis of rice yield, it is important to determine the elasticity of production (Ep) for this indicates the expected percentage increase (or decrease) in production that would occur if the amount of the input resource use increased or decreased by 1 per cent, other input levels being

---

Footnote 3, continued

Then substituting the value of Y of equation (3) into equation (5) we obtain:

$$Ep = b \; a \; x^b \; . \; \frac{1}{ax^b} = b \qquad (6)$$

4. Parish and Dillon (1955, pp. 215-236).
5. Jarrett (1957, pp. 67-78).
6. Plaxico (1955, pp. 664-675).

held constant. In notation form, the elasticity of production (Ep) can be presented as follows:

$$Ep = \frac{\partial Y}{\partial Xi} \quad \frac{Xi}{Y} \tag{2}$$

In other words, elasticity of production (Ep) is simply the marginal product, $\frac{\partial Y}{\partial Xi}$, divided by the average product.

In this study it is assumed that rice yield is a function of resource inputs such as, pre-harvest labour per hectare, rice variety, nitrogen in kilogram per hectare, operating costs per hectare, quality of irrigation, total rainfall, and solar energy. These variables may be included in a Cobb-Douglas production function as

$$Yc = a_0 \; a_1 \; a_2 \prod_{i=1}^{5} Xi^{b_i} \; ej$$

in logarithms

$$Yc = A_0 \; A_1 \; A_2 + \sum_{i=1}^{5} bi \; Xi + Ej$$

The notation and variables used are:

(a) Dependent variables

Yc = is the rice yield in cavans per hectare

(b) Independent variables

a_1 = dummy variable for rice variety

(0 = local; 1 = new)

a_2 = dummy variable for quality of irrigation

(0 = poor; 1 = good)

X_1 = man labour days per hectare is computed as an eight-hour day spent on a particular farm operation. It includes hired, exchange, family labour, including that of the operator from seedbed preparation to application of fertilizer and chemicals.

X_2 = elemental nitrogen in kilograms per hectare.

X_3 = operating costs in pesos per hectare (i.e. weedicide, herbicide, etc., except fertilizer and hired labour costs).

X_4 = total rainfall in millimeters. (Rainfall for each farm was calculated from the date of planting to date of harvest and based on the rainfall information recorded at UP College of Agriculture.

X_5 = total solar energy (g - cal/cm^2) 45-days before harvest. (Solar energy for each farm was calculated based on the solar energy measured at the IRRI.)

The actual statistical results of the estimation procedure are presented in Chapter 4.

2.7 Analysis of Resource Productivity

Hypothesis (2) of this thesis, that agricultural resources are being utilized inefficiently, is tested by resource productivity analysis.

At this stage it is worthwhile to define what are the resources and their marginal productivity. Resources in this analysis include land, labour, and operating capital. Marginal productivity means the addition to total product associated with a small change in total inputs or resource ($MP = \frac{\partial Y}{\partial Xi}$)

On the analysis of resource productivity, therefore, the regressors used to explain the dependent variable were land, labour and operating costs. One should note that not all independent variables used in the analysis of rice yield were used in the analysis of resource productivity, e.g. the dummy variables for variety, and quality of irrigation.

Going back to the discussion on the testing of the hypothesis (see section 1.3) the model used for this investigation was again a power function of the Cobb-Douglas form.

Hence we can use equation (2) to derive a marginal product from the elasticity coefficients.

$$MPi = \frac{\partial Y}{\partial Xi} = Epi \quad . \quad \frac{Y}{Xi} = bi \quad . \quad \frac{Y}{Xi} \qquad (7)$$

The function eventually chosen and used in the analysis of resource productivity is:

$$Yf = a\, X_6^{b_6} \;\; X_7^{b_7} \;\; X_8^{b_8} \qquad (8)$$

Where: Yf = farm income in pesos

X_6 = area planted in hectares

X_7 = operating costs in pesos

X_8 = man labour days

Description of variables

(a) Dependent variable

Y is the income received from the farm during the crop year.

(b) Independent variable

X_6 = the area planted, measured in total hectares planted to rice during the crop year.

X_7 = operating capital in pesos, including cash expenses for fertilizers, insecticides, herbicides, hired labour, and other cash expense items.

X_8 = man labour days, computed on the basis of an eight-hour day spent in a particular farm operation. It includes hired and exchange labour, family labour, including that of the operator, from seedbed preparation and hauling of threshed rough (unmilled) rice.

Since, from equation (7) the marginal productivities vary by resource level the average marginal products are derived from the production function, (8)

$$\frac{\partial Y}{\partial Xi} = bi\ \frac{\bar{Y}}{\bar{X}i}$$

Where $\bar{Y}$ and $\bar{X}i$ represent farm income and inputs at their geometric means.

A fundamental condition for the optimum use of resource inputs is that the marginal value product of Xi (to be designated by MVP_{Xi}) must be equal to its cost (to be designated by MFC_{Xi}).

This can be stated in the following manner:

$$MVP_{Xi} = MFC_{Xi} \qquad (9)$$

To test the hypothesis that agricultural resources are not being utilized efficiently, one must determine if there is a significant difference between the MVP_{Xi} and the MFC_{Xi}. Thus the t-test is used:

$$t = \frac{MVP-MFC}{S_b/\sqrt{n}} \qquad (10)$$

That is, t is the deviation of the MVP from the MFC. The denominator $S_b/\sqrt{n}$, is the estimate of the standard error of the mean of MVP.

The actual results of the estimation procedures are presented in Chapter 5.

CHAPTER 3

FARM DESCRIPTION, REVENUE AND COST AND COMPARISON OF RICE YIELDS BY LOCATION AND BY YEAR

This chapter describes the farms and analyses costs and revenues by type of adopters in the three selected areas; it thus provides a background for the subsequent economic analyses. The tenure status of the farm operator, sharing of farm expenses, size of farm holdings, type of irrigation, double cropping intensity, variety of rice planted and other farm cultural practices are all described. The items included in the analyses of revenues and costs have been discussed in Chapter 2. Finally, as an indication of the changes in rice yield on the adoption of new varieties, yield changes in the three areas under study are presented according to location and year. A non-parametric Mann-Whitney U-test is applied to the yield data to determine the significant differences among locations and among years.

3.1 Tenure Status

There was relatively little difference in the tenure status of the farm operators among the areas studied (Table 5).

TABLE 5

PERCENT OF FARMS REPORTING BY TYPE OF TENURE STATUS IN LAGUNA, PHILIPPINES, WET AND DRY SEASON, 1970

Tenure Status	Location					
	Biñan %		Cabuyao %		Calamba %	
Share tenant	94.0	(48)	91.7	(55)	86.2	(50)
Owner operator	4.0	(2)	2.3	(2)	1.7	(1)
Leaseholder	2.0	(1)	5.3	(2)	12.1	(7)
Part-owner	0.0	(0)	1.7	(1)	0.0	(0)
Total	100.0	(51)	100.0	(60)	100.0	(58)

Note: Figures in parentheses are number of farms reporting.

Approximately 90 per cent of the farmers surveyed in 1970 were share tenants. In Calamba there was a significant proportion of leaseholders (12.1 per cent), possibly because the Land Reform Programme of the government encouraged farmers to change from share tenant to leasehold arrangements, especially in areas where irrigation facilities were relatively good. The probable reason for the change of tenure status, was that farmers situated in relatively good irrigated areas were more confident that they could pay their land rentals and cost of operating inputs (which they would have to shoulder alone) easily because of the lesser risk of crop damage. Further study of this contention would be of great interest.

3.2 Sharing of Farm Expenses Between Landowner and Share Tenant

In the share-tenancy arrangement nearly all of the rent for the use of the land is based on equal sharing of 'profits' (on a 50 : 50 basis) between landowner and tenant. Profit is defined as gross revenue less the costs equally shared by the landlord and the tenant. The harvesters' and threshers' portions (3/20 to 1/8 of the crop), seed, fertilizers, other chemicals, transplanting costs, and the rice output are usually shared by the landlord and tenant. The tenant is responsible for the seedbed preparation and care, repair and cleaning of dikes and replanting. In some instances, hand weeding is done by the tenant alone or sometimes by both. Irrigation fees are paid by the landlord or the tenant and the operating cost for a pump is usually shared. The land tax is shouldered by the landlord (Table 6).

One cannot really draw a single dividing line to show clearly which expenses are shouldered by the landlord, which by the tenant, and which by both. Variations in the sharing arrangements may partly be explained by the existing landlord and tenant relationship and the sharing system customary in each area.

TABLE 6

THE SHARING OF FARM EXPENSES BETWEEN LANDOWNER AND TENANT-OPERATOR IN THREE SELECTED AREAS OF LAGUNA, PHILIPPINES, WET SEASON, 1970

	Location								
	BIÑAN			CABAYAO			CALAMBA		
	Land-owner	Tenant	Both	Land-owner	Tenant	Both	Land-owner	Tenant	Both
	Number of farms reporting								
Land Tax	41	0	0	58	0	0	54	0	0
Irrigation fee	14	2	28	2	5	35	43	0	2
Transplanting	5	1	29	10	1	41	19	0	24
Fertilizer	5	1	29	10	1	41	19	0	24
Seeds	3	1	31	24	2	45	2	0	41
Repair of pump[1]	2	0	1	18	4	15	-	-	-
Chemicals	0	1	34	1	4	46	6	16	21
Hauling of threshed palay	3	0	28	1	2	42	1	2	31
Food for hired & exchange labour	2	19	13	0	34	18	2	36	5
Seedbed preparation & care	0	26	9	1	47	4	0	43	0
Replanting	0	24	11	1	43	8	0	39	4
Winnowing	0	2	33	0	16	36	1	20	21
Land preparation	0	30	5	0	52	0	0	40	3
Repair & cleaning of dikes	0	33	2	0	51	1	0	43	0
Weeding (hand)	0	16	19	0	28	24	0	32	11
Harvesting & threshing	0	3	32	0	5	47	0	0	44

Note: 1 = All sample farms in Calamba are gravity irrigated, therefore no answer for this item is expected in the area.

3.3 Size of Rice Farm Holdings

The average area planted to rice ranged from 1.79 hectares in Calamba to 4.03 hectares in Biñan for the 1970 wet season, and from 1.77 hectares in Calamba to 3.25 hectares in Biñan for the 1970 dry season (Table 7).

TABLE 7

AVERAGE AREA PLANTED TO RICE IN THREE SELECTED AREAS IN LAGUNA, PHILIPPINES, WET AND DRY SEASON, 1970

Season	Location		
	BIÑAN	CABAYAO	CALAMBA
		(hectares)	
Wet	4.03 (41)	2.38 (59)	1.79 (55)
Dry	3.23 (14)	2.20 (40)	1.77 (53)

Note: Figures in parentheses are number of farms reporting.

As shown in the above table, the average size of rice farms in Calamba was smaller than in the other areas. The probable reason for the differences in average area cultivated was that farms in Biñan were less productive in terms of output per hectare (see rice yield comparison by location in Table 29, section 3.10 of this Chapter) than in Calamba, and so they must increase the area they cultivate in order to produce more from farming. In addition, the relative net income per hectare shown in Table 21 revealed also that farms in Calamba obtained the highest net income per hectare, followed by Cabayao and finally by Biñan.

Sizes of area planted to rice tended to decrease during the dry season. This was probably due to the water problem, especially in a poorly irrigated area like Biñan.

3.4 Type of Irrigation and Intensity of Double-Cropping

Table 8 exhibits the percentage of farms reporting good and poor irrigation by location, and the intensity of double-cropping for the wet and dry seasons of 1970.

Definitions of poor and good irrigation were given in Chapter 2, section 2.4

TABLE 8

PERCENTAGE OF FARMS REPORTING BY TYPE OF IRRIGATION AND DOUBLE-CROPPING INTENSITY, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/ Type of Irrigation	Location		
	Biñan (%)	Cabuyao (%)	Calamba (%)
Wet Season			
Poor irrigation	85.0	32.0	5.0
Good irrigation	15.0	68.0	95.0
Total	100.0 (41)	100.0 (59)	100.0 (55)
Season			
Poor irrigation	28.0	8.0	2.0
Good irrigation	72.0	92.0	98.0
Total	100.0 (14)	100.0 (40)	100.0 (53)
Double-Cropping intensity	27.0	62.0	95.0

Note: Figures in parentheses are number of farms reporting.

There seems to be major differences in the percentage of farms reporting between seasons in Biñan and Cabuyao. This is so because only farms with relatively good irrigation were able to plant during the dry season (as shown by the decrease in the number of farms reporting in Cabuyao and Calamba during the dry season) except for some farmers who were still willing to risk their crops even with poor irrigation.

One could also deduce from Table 8, that intensity of double-cropping was closely related to the type of irrigation system present in the area. Double-cropping intensity was 95 per cent in Calamba where irrigation was reported to be good, and 27 per cent in Biñan where irrigation was considered to be poor.

TABLE 9

PER CENT OF FARMS REPORTING THE RICE VARIETIES PLANTED IN LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/Variety	Location		
	Biñan (%)	Cabuyao (%)	Calamba (%)
Wet Season			
Local variety (sub-total)	0	20	19
Malagkit sungsong[1]		18	17
Intan			1
Thailand (Binato)		1	
Wagwag			1
Raminad			
Tjere-mas			
Other local varieties		1	
New variety (sub-total)	100	80	81
BPI-76			
IR 8	51	48	44
IR 5		1	2
C4-63	43	17	9
IR-Malagkit[2]		9	
IR 20	2	1	3
Other new varieties	2		
Grand total	100 (55)	100 (85)	100 (96)
Dry Season			
Local variety (sub-total)	12	40	18
Malagkit sungsong[1]	6	8	14
Intan	6	28	4
Thailand (Binato)			
Wagwag		4	
Raminad			
Tjere-mas			
Other local varieties			
New variety (sub-total)	88	60	82
BPI-76			
IR 8	60	42	62
IR 5	11	2	3
C4-63	11	7	9
IR-Malagkit[2]		2	
IR 20	6	7	8
IR 22			
Other new varieties			
Grand total	100 (14)	100 (41)	100 (55)

Notes: 1. A glutinous local variety planted especially for making rice cakes.
2. A glutinous new variety.

Figures in parentheses are number of farms reporting.

3.5 Variety of Rice Planted

The rice varieties planted in three selected areas in the wet and dry seasons of 1970 are shown in Table 9. The percentage of farms planting local varieties during the wet season ranged from zero in Biñan to 20 in Cabuyao. During the dry season, plantings of local varieties ranged from 12 per cent in Biñan to 40 per cent in Cabuyao. This shows that for both seasons, plantings of new varieties were tremendously high in Biñan where many of the farms are poorly irrigated. A possible reason why farmers in poorly irrigated areas planted the new varieties was the early maturity of the new varieties (110 to 120 days) compared to the local varieties (120 to 140 days). The decision to plant new varieties minimized the risk of drought damage, especially in the poorly irrigated areas.

The over-all trend of adoption of new varieties increased from 1966 to 1971 (see Appendix Tables A and B).

3.6 Farm Cultural Practices

3.6.1 Raising of Rice Seedlings

All farmers in the three sample areas adopted the dapog method of raising rice seedlings, for both the wet and dry seasons of 1970 (Table 10). The advantages of the dapog method are: (a) Less area is needed to grow dapog seedlings. Only 40 sq.m. of seedbed are needed, compared to an area of 300 to 500 sq.m. for the wetbed method, to grow seedlings for one hectare of fields; (b) Seedlings are raised faster by the dapog method than by the other method. Dapog seedlings can be transplanted 10 to 12 days after sowing while the wetbed seedlings are transplanted bast at 20 to 30 days old. So, if a farmer lacks time to raise the seedlings before transplanting, he may use the dapog method; (c) In the dapog method pulling up of seedlings is not necessary. When the seedlings are ready for transplanting they are just rolled up like a carpet. Hence the expense of removing seedlings from the seedbed is less since no pulling up is required.[7]

TABLE 10

METHOD OF RAISING SEEDLINGS BY PERCENTAGE OF FARMS REPORTING, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/Method	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
Wet Season			
Dapog	100.0	100.0	100.0
Wetbed	0	0	0
Total	100.0 (41)	100.0 (59)	100.0 (55)
Dry Season			
Dapog	100.0	97.6	100.0
Wetbed	0	2.4	0
Total	100.0 (14)	100.0 (41)	100.0 (55)

Note: Figures in parentheses are number of farms reporting.

3.6.2 Land Preparation

The majority of the farmers surveyed used the carabao for plowing and the tractor or a combination of the carabao and hand tractor for harrowing (Table 11). Normally carabaos are owned by the farmer, while hand tractors are hired.

The reason why hand tractors were more commonly used in harrowing then in plowing was probably that it saves time. In order to do the transplanting work earlier harrowing must be done in a shorter period and this is only possible with the use of hand tractors.

Use of hand tractors varied also according to location. There were more farmers using hand tractors in Biñan than in Calamba, probably because

7. For a detailed discussion of the two methods in raising seedlings, see Macalinga and Obordo (1970, pp. 78-83).

of the larger size of farms cultivated in Biñan than in Calamba, making the use of the hand tractor more economical than the carabao. The findings of the study of Tractor and Carabao Cultivated Farms in Laguna (Alviar, 1967), indicate that tractor demand is most likely to appear in areas where farms are larger than average. The other reason why hand tractors were more popular in Biñan than in Calamba was the problem of lack of irrigation water in the former. Farmers in Biñan can break the soil only after the rain starts to fall. If the showers are late, the whole operation is delayed. Naturally, all operations must then be performed hurridly and they can not be done as quickly with carabao as with the hand tractor.

TABLE 11

LAND PREPARATION PRACTICES IN THREE SELECTED AREAS, BY PER CENT OF FARMS REPORTING, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Item	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
Plowing			
Wet Season			
Hand tractor	26.8	14.7	1.8
Carabao	70.7	82.0	98.2
Both	2.5	3.3	0.0
Total	100.0 (41)	100.0 (59)	100.0 (55)
Dry Season			
Hand tractor	42.9	26.8	3.6
Carabao	57.1	70.7	94.6
Both	0.0	2.5	1.8
Total	100.0 (14)	100.0 (41)	100.0 (55)
Harrowing			
Wet Season			
Hand tractor	48.8	44.2	14.0
Carabao	19.5	27.9	36.9
Both	31.7	27.9	49.1
Total	100.0 (41)	100.0 (59)	100.0 (55)
Dry Season			
Hand tractor	57.1	56.1	14.5
Carabao	14.3	26.8	36.4
Both	28.6	17.1	49.1
Total	100.0 (14)	100.0 (41)	100.0 (55)

Note: Figures in parentheses are number of farms reporting.

3.6.3 Transplanting

Straight-row (2 directions) planting was most commonly used in the areas studied (Table 12). The advantages of the straight-row method are: (a) it facilitates mechanical weeding, (b) optimum plant spacing is possible and farmers find aesthetic satisfaction in watching their crops planted in straight rows, and (c) it facilitates application of fertilizer, weedicides, insecticides and pesticides. On the other hand, the ordinary method, used extensively in most growing areas in the Philippines, was not commonly used in the areas studied. This indicates that the standard of management was relatively good in the areas studied.

TABLE 12

TRANSPLANTING METHOD BY PER CENT OF FARMS REPORTING IN THREE AREAS, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/Method	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
Wet Season			
Straight-row method (2 directions)	73.2	59.0	64.9
Straight-row method (1 direction)	17.1	16.4	24.6
Ordinary method	9.7	24.6	10.5
Total	100.0 (41)	100.0 (59)	100.0 (55)
Dry Season			
Straight-row method (2 directions)	57.1	61.0	54.5
Straight-row method (1 direction)	28.6	9.8	30.9
Ordinary method	14.3	29.2	14.6
Total	100.0 (14)	100.0 (41)	100.0 (55)

Note: Figures in parentheses are number of farms reporting.

3.6.4 Fertilizing Methods and Types

Fertilizer application was practiced by almost all farmers in the three areas studied. Fertilizer was applied either before (basal method) or after (top-dressing method) transplanting. However, the method commonly practices by farmers in the three areas studied was the top-dressing method Table 13), for both the wet and the dry seasons. Farmers probably applied their fertilizer when the crop was already standing because they could then easily tell that the crop was utilizing the fertilizer effectively when the plant leaves changed colour from yellowish-green to darker green. Farmers believe that basal application is just a waste of money because of nitrogen losses due to surface flow.

TABLE 13

METHOD OF FERTILIZER APPLICATION BY PER CENT OF FARMS REPORTING, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/Method of Application	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
Wet Season			
Top-dressing	95.2	88.6	96.4
Basal	0	1.6	0
Basal and top-dressing	2.4	8.2	1.8
No fertilizer	2.4	1.6	1.8
Total	100.0 (41)	100.0 (59)	100.0 (55)
Dry Season			
Top-dressing	85.7	85.4	92.7
Basal	0	0	0
Basal and top-dressing	14.3	14.6	5.5
No fertilizer	0	0	1.8
Total	100.0 (14)	100.0 (41)	100.0 (55)

Note: Figures in parentheses are number of farms reporting.

A statistical test of mean yield of rough rice by method of application was done in the sample farms. The test showed that grain yield differences by method of application were not significant even as high as the 20 per cent level (Table 14).

Results during 1966 - 1967 at the IRRI experimental station show that, with the lodging resistant IR8 variety, grain yield differences were not significant for time of nitrogen application.

The kind of fertilizer applied was mostly urea for both seasons (Table 15). A bag of urea (weighing 50 kg) commonly sold in the area contains

TABLE 14

MEAN YIELD OF ROUGH (UNMILLED) RICE AND TEST OF SIGNIFICANCE BY METHOD OF FERTILIZER APPLICATION, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

	1970 Wet		1970 Dry	
Method of application	Yield	t-computed	Yield	t-computed
	cavan/ha		cavan/ha	
Top-dressing	74.61 (148)	1.1323	86.16(96)	0.424
Basal and top-dressing	91.14 (7)		90.45(11)	

Note: All t-values are not significant at 5 per cent level. Figures in parentheses are degrees of freedom.

45 per cent of elemental nitrogen while a bag of ammonium sulphate (weighing 45 kg) contains 21 per cent nitrogen. The average rate of elemental nitrogen applied by location and by season will be shown in Chapter 4, Table 40.

TABLE 15

KIND OF FERTILIZER USED BY PER CENT OF FARMS REPORTING, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

	Location		
Season/Kind of fertilizer	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
Wet Season			
Urea	80.5	91.8	89.5
Ammonium sulphate	0	1.6	1.8
Other kind	17.1	5.0	6.9
No fertilizer applied	2.4	1.6	1.8
Total	100.0 (41)	100.0 (59)	100.0 (55)
Dry Season			
Urea	92.2	8.29	92.8
Ammonium sulphate	0	0	1.8
Other kind	7.8	17.1	3.6
No fertilizer applied	0	0	1.8
Total	100.0 (14)	100.0 (41)	100.0 (55)

Note: Figures in parentheses are number of farms reporting.

3.6.5 Weeding Method, Type and Timing of Herbicide Application

Most of the farmers in the area studied used a combination of hand weeding, rotary weeding and chemicals (herbicides) to remove obnoxious weeds (Table 16).

The chemical herbicide commonly used was liquid in form, e.g. 2, 4-D (Table 17). This liquid herbicide was sprayed after the weeds emerged (Table 18), or just before mechanical or hand weeding took place. The rate of application of herbicides per hectare ranged from 6.50 pesos from Biñan to 10.0 pesos in Cabuyao in the wet season and from 6.00 pesos in Calamba to 9.00 pesos in Cabuyao in the dry season. The rotary or mechanical weeder was commonly used in farms where straight-row planting was practiced. The advantage of the rotary weeder over hand weeding is that it facilitates faster weeding. IRRI data show that under average conditions, it takes 120 hours to hand weed one hectare, and 70 hours to weed it by rotary weeder. At this stage, however, no study had shown proof of a significant increment in yield by the use of the rotary weeder over hand weeding.

TABLE 16

WEEDING METHOD PRACTICED BY PER CENT OF FARMS REPORTING, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/Weeding method	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
Wet Season			
1. Chemical only	0.0	0.0	0.0
2. Hand weeding only	0.0	1.6	0.0
3. Rotary weeding only	2.4	1.6	0.0
4. Combination of 1, 2	7.3	21.3	12.3
5. Combination of 1, 3	12.2	11.5	10.5
6. Combination of 2, 3	4.9	1.6	1.8
7. Combination of 1, 2, 3	73.2	62.4	75.4
8. No weeding	0.0	0.0	0.0
Total	100.0 (41)	100.0 (59)	100.0 (55)
Dry Season			
1. Chemical only	0.0	0.0	0.0
2. Hand weeding only	7.0	4.8	0.0
3. Rotary weeding only	0.0	2.4	1.8
4. Combination of 1, 2	14.0	29.2	12.7
5. Combination of 1, 3	0.0	7.5	12.7
6. Combination of 2, 3	0.0	0.0	1.8
7. Combination of 1, 2, 3	0.0	56.1	69.0
8. No weeding	79.0	0.0	2.0
Total	100.0 (14)	100.0 (41)	100.0 (55)

Note: Figures in parentheses are number of farms reporting.

TABLE 17

KIND OF HERBICIDE APPLIED IN THREE SELECTED AREAS, BY PER CENT OF FARMS REPORTING, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/Kind of herbicide applied	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
Wet Season			
Liquid herbicide	92.7	95.2	93.0
Granular herbicide	0.0	0.0	0.0
Wettable herbicide	0.0	1.6	1.8
Combination of different kinds	0.0	1.6	1.8
No application	7.3	1.6	3.4
Total	100.0 (41)	100.0 (59)	100.0 (55)
Rate of application (Pesos/ha)	6.58	9.96	6.97
Dry Season			
Liquid herbicide	9.29	92.7	98.2
Granular herbicide	0.0	2.4	0.0
Wettable herbicide	0.0	0.0	1.8
Combination of different kinds	0.0	0.0	0.0
No application	7.1	4.9	0.0
Total	100.0 (14)	100.0 (41)	100.0 (55)
Rate of application (Pesos/ha)	6.16	8.81	6.05

Note: Figures in parentheses are number of farms reporting.

TABLE 18

TIME OF HERBICIDE APPLICATION BY PER CENT OF FARMS REPORTING, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/Time of application	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
Wet Season			
Pre-emergence application	12.2	11.5	7.0
Post-emergence application	75.6	73.8	87.7
Pre- and post-emergence appln.	4.9	13.1	1.8
No application	7.3	1.6	3.5
Total	100.0 (41)	100.0 (59)	100.0 (55)
Dry Season			
Pre-emergence application	7.1	14.6	5.5
Post-emergence application	85.8	68.3	94.5
Pre- and post-emergence appln.	0.0	12.2	0.0
No application	7.1	4.9	0.0
Total	100.0 (14)	100.0 (41)	100.0 (55)

Note: Figures in parentheses are number of farms reporting.

3.6.6 Test of Significance by Time of Herbicide Application

A statistical test of mean yield of rough rice by time of pesticide application was done in the three areas studied for both wet and dry seasons. The test showed that grain yield differences by time of herbicide application were not significant even as high as the 20 per cent level except the pre- and post-emergence against post-emergence in the wet season (Table 19). This could probably be explained by the fact that pre-emergence application was quite a new technique of controlling weeds and farmers may not have been using the right time of application because they were afraid that the rice seedlings would also be killed. Vega and De Datta (1970) pointed out that one of the points that farmers should observe in the effictive application of herbicide, is that it is important to apply herbicides accurately, because inadequate amounts give unsatisfactory weed control and an excessive dose may harm the crop.

TABLE 19

MEAN YIELD OF ROUGH (UNMILLED) RICE AND TEST OF SIGNIFICANCE BY TIME OF HERBICIDE APPLICATION, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/Time of application	Yield	t-computed		Degree of freedom
	(cavan/ha)			
Wet Season				
Pre-emergence	82.3			
		0.448		10
Post-emergence	86.7		0.741	122
		1.831*		10
Pre- and post-emergence	74.0			
Dry Season				
Pre-emergence	69.4			
		0.788		9
Post-emergence	75.3		0.807	91
		0.271		4
Pre- and post-emergence	77.4			

* Significant at 20 per cent level.

3.6.7 Pest and Disease Control

This refers to the use of any kind of insecticide or pesticide to control pests and diseases. Liquid insecticide (e.g. Endrin) was the most common chemical insecticide used by the farmers (Table 20). This kind of insecticide was popular in the area because farmers could purchase it in a smaller quantity at a price they could afford, unlike the granular and wettable powder forms of insecticide which were sold in greater bulk. Thus an ordinary farmer who could afford only a ₱3.00 bottle of liquid insecticide would think twice before buying a bag of granular insecticide costing him approximately ₱4o to ₱50 per bag. This was in spite of the fact that granular insecticides have been found to be more effective in killing destructive insects like stemborers, one of the major insect pests attacking rice plants in the Philippines.

TABLE 20

PER CENT OF FARMS REPORTING BY KIND OF INSECTICIDE USED IN THREE SELECTED AREAS, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/Kind of insecticide applied	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
Wet Season			
Liquid insecticide	70.7	44.3	80.7
Granular insecticide	4.9	8.2	1.8
Wettable powder insecticide	2.4	1.6	1.8
Combination of different kinds of insecticide	22.0	26.2	3.5
No insecticide application	0.0	19.7	12.2
Total	100.0 (41)	100.0 (59)	100.0 (55)
Rate of application (Pesos/ha)	15.4	14.2	9.9
Dry Season			
Liquid insecticide	92.9	48.8	87.3
Granular insecticide	0.0	19.5	0.0
Wettable powder insecticide	7.1		
Combination of different kinds of insecticide	0.0	22.0	3.6
No insecticide application	0.0	9.7	9.1
Total	100.0 (14)	100.0 (41)	100.0 (55)
Rate of application (Pesos/ha)	13.3	14.0	8.9

Note: Figures in parentheses are number of farms reporting.

On the average the amount (in pesos/hectare) spent on insecticides by the farmers in the areas studied ranged from 9.9 pesos in Calamba, to 15.4 pesos in Biñan during the wet season. For the dry season, the amounts were slightly lower than for the wet season (Table 20).

3.6.8 Time of Insecticide Application

The major percentage of the farmers in the three areas studies reported application of insecticide at the time when damage to the rice crop was observed (Table 21). This situation was true for both wet and dry season. Farmers probably waited until they actually saw the damage to the crop because they were reluctant to spend their limited cash on the purchase of insecticide, while there was any doubt that the insect would damage the crop.

TABLE 21

TIME OF INSECTICIDE APPLICATION BY PER CENT OF FARMS REPORTING, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/Time of application	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
Wet Season			
Applied before insect attack	24.4	14.8	14.0
Applied at time of attack	65.8	49.2	64.9
Applied at both times	9.8	16.4	8.8
No application	0.0	19.6	12.3
Total	100.0 (41)	100.0 (59)	100.0 (55)
Dry Season			
Applied before insect attack	14.3	19.5	16.3
Applied at time of attack	78.6	58.5	67.3
Applied at both times	7.1	12.2	7.3
No application	0.0	9.8	9.1
Total	100.0 (14)	100.0 (41)	100.0 (55)

Note: Figures in parentheses are number of farms reporting.

3.6.9 Test of Significance by Time of Insecticide Application

Table 22 shows that differences in grain yield by time of insecticide application were not significant even at the 20 per cent level of significance. The reason was most probably that farmers still lacked sufficient knowledge of the kind and amount of insecticide to use for a specific insect attack.

TABLE 22

MEAN YIELD OF ROUGH (UNMILLED) RICE AND TEST OF SIGNIFICANCE BY TIME OF INSECTICIDE APPLICATION, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/Time of application	Yield (cavan/ha)	t-computed		Degree of freedom
Wet Season				
Applied before insect attack	86.0			
		0.119		26
Applied at time of insect attack	87.1		0.844	91
		1.117		18
Applied at both times	94.4			
Dry Season				
Applied before insect attack	74.3			
		0.363		20
Applied at time of insect attack	76.9		0.612	71
		0.422		9
Applied at both times	80.3			

All computed t-values are not significant at 20 per cent level.

3.6.10 Harvesting, Threshing and Winnowing

Hand harvesting with sickle is still typical in the three areas studied. The stalks are cut long enough so that when threshing the thresher will be able to hold bundles of rice and swing them overhead and beat off the grain. After cutting, the stalks are left to dry in the field. However, during a period of high humidity or when the farmers are afraid that the harvested crop will be stolen if allowed to stay overnight on the field, threshing of freshly harvested rice is necessary. If the threshing is to be done later the plants are piled into stacks. The panicles are placed toward the centre to permit further drying of the grains.

Threshing is usually done by beating the panicles with a wooden stick or by hitting the stalks on a wooden frame. The sides of the wooden frame are partially covered with canvas to prevent the scattering of the grain.

Before sacking, the threshed (unmilled) rice is winnowed to remove some of the foreign matter and unfilled grains. Winnowing is normally done by letting the grains fall on the canvassed ground and allowing the wind to blow the foreign matter and unfilled grains. This may be done manually or by the use of a mechanical winnower locally termed as hungkoyan.

The job of harvesting, threshing and winnowing is contracted normally to the same person, since it is difficult for the farmer to separate the payment for each of the above activities. In other words, the person who harvested the crop is also the one who is responsible for threshing and winnowing. In some instances, the harvesters will even offer to weed the farm free of charge in exchange for the privilege of harvesting the area exclusively.

Payment for harvesting, threshing and winnowing is usually in kind and it ranged from 3/20 th of the total crop in Biñan to 1/8 th in Cabuyao and Calamba. One may wonder why payment for harvesters was slightly higher in Biñan than in Cabuyao and Calamba. The probable reason for the difference in payment from place to place was that productivity (yield/ha) of the farmers in Biñan was lower than in Cabuyao and Calamba.

3.7 Labour Requirements of Cultural Practices

Labour requirements per hectare ranged from 88 man/days/ ha to 93 man/day/ha in the wet season and 85 man/days/ha to 101 man/days/ha in the dry season. Table 23 shows only slight differences in the labour requirements among the three sample areas and between the wet and dry seasons. It also shows that the labour requirements for harvesting and other post-harvest practices were higher for any other cultural practice.

Labour in the farm is provided by hired, family, exchange and operators labour. Of the total labour required per hectare, the largest proportion (50 per cent or more) was provided by hired labour for both wet and dry seasons for the three areas studied (Table 24). From the same table, the percentage of hired labour was relatively higher in rolling and distributing of seedlings, transplanting, harvesting and threshing, and hauling of threshed (unmilled) rice. The contributions, in percentage terms of all types of labour are presented in Appendices C and D.

TABLE 23

LABOUR REQUIREMENTS PER HECTARE IN MAN DAYS PER HECTARE, THREE SAMPLE AREAS, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Cultural Practices	Location					
	Biñan		Cabuyao		Calamba	
	Wet	Dry	Wet	Dry	Wet	Dry
	(man/day/ha)		(man/day/ha)		(man/day/ha)	
A. Pre-harvest labour						
Seedbed preparation & care	2.49	2.93	2.52	3.16	2.99	5.93
Plowing	5.60	6.31	6.04	5.41	6.27	6.13
Harrowing	4.69	4.06	5.86	4.59	6.39	5.72
Repair & cleaning of dikes	4.68	7.33	5.31	5.39	4.72	4.65
Rolling & distributing of seedlings	0.50	0.59	0.53	0.57	0.61	0.54
Transplanting	9.07	8.78	9.28	8.75	9.84	9.69
Replanting	5.66	6.34	4.98	5.16	3.99	5.13
Weeding	21.75	15.63	15.60	18.15	19.00	18.59
Chemical application	1.09	0.98	0.77	2.67	0.86	1.55
Fertilizing	0.80	0.86	0.53	1.01	1.05	1.05
B. Harvesting, threshing, winnowing and hauling of threshed (unmilled) rice	36.92	38.75	36.82	30.09	34.30	42.00
Grand total	93.45	92.56	88.24	84.95	90.08	101.00

TABLE 24

HIRED LABOUR IN PROPORTION TO THE TOTAL LABOUR REQUIREMENTS BY CULTURAL PRACTICES AND BY LOCATION, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

	Location					
	Biñan		Cabuyao		Calamba	
Cultural Practices	Wet	Dry	Wet	Dry	Wet	Dry
	(per cent)		(per cent)		(per cent)	
A. Pre-harvest labour						
Seedbed preparation & care	40	15	2	4	2	0
Plowing	36	30	35	46	36	35
Harrowing	29	54	38	47	39	42
Repair & cleaning of dikes	17	11	19	19	19	20
Rolling & distributing of seedlings	80	70	72	70	76	78
Transplanting	98	100	100	100	99	100
Replanting	39	18	20	27	21	14
Weeding	39	64	54	67	48	43
Chemical application	3	5	13	17	7	0
Fertilizing	12	0	17	3	9	1
B. Harvesting, threshing, winnowing and hauling of threshed (unmilled) rice	99	100	90	100	94	100
Grand total	66 (93)	70 (92)	68 (88)	71 (85)	66 (96)	72 (101)

Note: Figures in parentheses are total labour in man days per hectare.

3.8 Revenue and Costs per Hectare by Location

The gross revenues and costs per hectare of producing rice in the three areas studied are presented in Table 25. Rice farmers in Calamba obtained the highest net income per hectare (₱1,264), followed by Cabuyao (₱708), and finally Biñan (₱561), while the prices received by the farmers were almost the same in the three locations. This difference in net income per hectare may be due to the fact that areas cultivated in Calamba are smaller than in Biñan and Cabuyao, thus allowing the farmers to use their capital more intensively. It may also be due to the fact that farms in that area are fully irrigated (Table 8, in section 3.4), thus making it possible for the farmers to schedule the application of chemicals (e.g. fertilizer) and other cultural practices, possibly leading to the higher yield and also higher MVP of land (Table 47).

The results also showed that the cost per cavan of rough (unmilled) rice produced was relatively less in Calamba (₱6.64 per cavan) than in Cabuyao (₱10.52 per cavan), and in Biñan (₱10.54 per cavan). Production costs in Calamba are relatively lower than in the other two areas because yield (cavan/ha) is much higher while the variable costs are almost the same. One would observe that irrigation cost in ₱/ha in Calamba is relatively low, even if farms are fully irrigated, because the system falls under the gravity system which is handled by the government, which is charging the same fee throughout, regardless of whether the system is providing sufficient water or not.

The result of this analysis will presumably indicate a higher efficiency in the use of land and operating capital in Calamba than in the other two areas (as shown by the relatively high MVPs of land and operating capital in Table 47). The differences in rice yield among the three locations will be discussed further in Chapter 4.

TABLE 25

REVENUE AND COSTS BY LOCATION, THREE AREAS IN LAGUNA, PHILIPPINES, WET SEASON, 1970

Item	Location			
	Biñan	Cabuyao	Calamba	All farms
	(₱/ha)	(₱/ha)	(₱/ha)	(₱/ha)
<u>Gross Revenue</u>				
Yield (cavan/ha)	59	68	99	77
Price of rice (₱/cav)	20.10	20.55	21.02	20.63
Gross revenue (₱/ha)	1,182	1,419	1,921	1,520
<u>Cash Farm Expenses</u>				
Fertilizer	57	88	84	79
Insecticide	18	18	11	15
Weedicide	7	11	7	9
Irrigation cost	22	46	21	31
Seeds	26	37	25	30
<u>Hired Labour</u>				
Seedbed preparation & care	19	8	6	12
Plowing	45	55	42	48
Harrowing	52	58	56	56
Repair & cleaning of dikes	23	16	14	16
Rolling & distributing of seedlings	4	4	4	4
Transplanting	48	55	46	50
Replanting	25	19	3	22
Weeding	50	61	45	54
Insecticide application	3	4	6	4
Fertilizer application	3	3	10	4
Harvesting & threshing	174	177	239	199
Winnowing	23	24	14	20
Hauling	23	26	25	25
Total Cash Farm Expenses	621	710	657	668
Cost of producing a cavan of rice (₱/cavan)	10.54	10.52	6.64	8.72
Net Income (₱/ha)	561	708	1,264	852
Number of farms	(41)	(59)	(55)	(155)
Average area planted (ha)	4.03	2.38	1.79	

3.9 Revenue and Costs per Hectare by Type of Adopter

Types of adopters consist of full, partial and non-adopters of new rice varieties. These different types of adopters have already been defined (section 2.4).

In Biñan, all the farmers reported plantings of new rice varieties, so revenues and costs refer to full adopters only.

In Cabuyao, the non-adopters obtained the highest net income of about ₱2,238 per hectare, followed by the partial adopters (₱1,765 per hectare) and finally ₱1,244 per hectare for the full adopters (Tables 26, 27 and 28). The relatively higher variable inputs used by the partial adopters and non-adopters coupled with a much better price received for their produce would explain the higher net income received. The situation in Cabuyao is quite interesting because non-adopters produced more rice per unit area than those farmers who adopted the new varieties. The cost of production per cavan of rice was much less for the non-adopters than for the full adopters.

In Calamba, the partial adopters obtained the highest net income (₱1,492), followed by the full adopters (₱1,199) and finally by the non-adopters (₱1,157). The crucial factor here was the high average yield of partial adopters (105 cavans per hectare), compared to 98 cavans per hectare for full adopters, and 81 cavans per hectare for non-adopters. The returns per cavan of producing rice depended heavily on yields rather than on the price received. As shown in Table 28, the higher price received by the non-adopters did not increase very much the returns per hectare of producing rice compared to the slightly lower price received by the partial adopters.

TABLE 26

REVENUE AND COSTS BY LOCATION OF FULL ADOPTERS, THREE AREAS IN LAGUNA, PHILIPPINES, WET SEASON, 1970

Item	Location			
	Biñan	Cabuyao	Calamba	All farms
	(₱/ha)	(₱/ha)	(₱/ha)	(₱/ha)
Gross Revenue				
Yield (cavan/ha	59	64	98	73
Price of rice (₱/cav)	20.10	19.43	18.70	19.49
Gross revenue (₱/ha)	1,182	1,244	1,834	1,410
Cash Farm Expenses				
Fertilizer	57	86	78	74
Insecticide	18	17	11	15
Weedicide	7	10	7	8
Irrigation cost	22	36	21	26
Seeds	26	36	23	30
Hired Labour				
Seedbed preparation & care	19	8	7	13
Plowing	45	54	45	48
Harrowing	52	64	57	59
Repair & cleaning of dikes	23	16	15	17
Rolling & distributing of seedlings	4	5	4	4
Transplanting	48	57	45	50
Replanting	25	21	3	23
Weeding	50	66	34	53
Insecticide application	3	4	6	4
Fertilizer application	3	3	10	4
Harvesting & threshing	174	158	230	186
Winnowing	23	22	14	20
Hauling	23	29	25	26
Total Cash Farm Expenses	621	693	635	662
Cost of producing a cavan of rice (₱/cavan)	10.54	10.83	6.47	9.05
Net Income (₱/ha)	561	551	1,199	748
Number of farms	(41)	(44)	(38)	(123)

TABLE 27
REVENUE AND COSTS BY LOCATION OF PARTIAL ADOPTERS, THREE AREAS IN LAGUNA, PHILIPPINES, WET SEASON, 1970

Item	Location		
	Cabuyao	Calamba	All farms
	(₱/ha)	(₱/ha)	(₱/ha)
Gross Revenue			
Yield (cavan/ha)	78	105	94
Price of rice (₱/cav)	22.72	20.75	21.38
Gross revenue (₱/ha)	1,765	2,181	2,018
Cash Farm Expenses			
Fertilizer	98	100	99
Insecticide	17	10	13
Weedicide	11	6	8
Irrigation cost	72	22	44
Seeds	38	31	34
Hired Labour			
Seedbed preparation & care	0	1	1
Plowing	52	32	41
Harrowing	50	52	51
Repair & cleaning of dikes	4	15	14
Rolling & distributing of seedlings	3	4	4
Transplanting	56	46	50
Replanting	10	0	10
Weeding	54	65	58
Insecticide application	5	5	5
Fertilizer application	0	0	0
Harvesting & threshing	210	267	245
Winnowing	25	14	18
Hauling	13	19	16
Total Cash Farm Expenses	723	694	709
Cost of producing a cavan of rice (₱/cavan)	9.47	6.60	7.54
Net Income	1,042	1,487	1,309
Number of farms	(9)	(14)	(23)

TABLE 28

REVENUE AND COSTS BY LOCATION OF NON-ADOPTERS, THREE AREAS IN LAGUNA, PHILIPPINES, WET SEASON, 1970

Items	Location		
	Cabuyao	Calamba	All farms
	(₱/ha)	(₱/ha)	(₱/ha)
Gross Revenue			
Yield (cavan/ha)	80	81	80
Price of rice (₱/cav)	28.15	22.74	26.33
Gross revenue	2,238	1,856	2,110
Cash Farm Expenses			
Fertilizer	89	89	89
Insecticide	34	14	29
Weedicide	13	8	11
Irrigation cost	67	20	60
Seeds	39	31	37
Hired Labour			
Seedbed preparation & care	0	0	0
Plowing	72	45	66
Harrowing	25	45	28
Repair & cleaning of dikes	0	12	12
Rolling & distributing of seedlings	3	6	4
Transplanting	42	59	46
Replanting	0	0	0
Weeding	48	82	53
Insecticide application	1	0	1
Harvesting & threshing	275	232	261
Winnowing	31	10	12
Hauling	27	45	31
Total Cash Farm Expenses	765	699	730
Cost of producing a cavan of rice (₱/cavan)	9.62	8.58	9.11
Net Income	1,473	1,157	1,380
Number of Farms	(6)	(3)	(9)

3.10 Comparison of Mean Yields - by Location and by Year

This section examines how yields altered after the adoption of new varieties. The mean yeilds per hectare were compared between locations within years (Table 29) and between years within locations (Table 30).

Before proceeding to the tests of differences among means, the homogeneity of variances among these groups of farms was first determined using Bartlett's S-test and F-maximum test.[8]

Where these tests indicate heterogeneity of variance, conventional analysis of variance and use of Duncan's or similar parametric multiple range tests are inappropriate. In this situation appropriate non-parametric tests must be used, such as the Wilcoxon-Mann-Whitney "U" test.

The Mann-Whitney "U" test is one of the most effective of the non-parametric tests, and it is a most useful alternative to the parametric t-test when one wishes to avoid the t-test assumptions.[9]

The results of Bartlett's test showed that the variances among the groups of farms were mostly heterogeneous by location and by year, except for a few years like 1966-68 and 1971, and it was necessary to use the Mann-Whitney "U" test to determine the differences among means of rice yields per hectare among the groups of farms.

The Mann-Whitney "U" test is used to determine whether two independent groups have been drawn from the same population. The null-hypothesis, H_0, is that $\bar{X}_1$, the mean of the first group, and $\bar{X}_2$, the mean of the second group, have the same distribution. The alternative hypothesis, H_1, is that $\bar{X}_1$ is stochastically different from $\bar{X}_2$. To reject or accept the null-hypothesis, H_0, is to compare the probability associated with values within the range of observed values of "Z" in the normal distribution with the level of significance (α), which was previously set. The table of probability is given in Siegel (1956). If the probability associated with the observed value of "Z" in the normal distribution is less than the previously assigned

8. Steel and Torrie (1969, pp. 347-349).

9. Siegel (1956, p. 19).

level of significance (α), then the hypothesis, H_0, is rejected and the alternative hypothesis, H_1, is accepted. Alternatively, if the probability associated with the observed value of "Z" in the normal distribution is greater than or equal to the previously set level of significance (α), then the null-hypothesis, H_0 is accepted.

Tables 29 and 30 show the results of the Mann-Whitney "U" test. Yields tended to vary significantly between location within year, whilst yields within location and between years were somewhat more stable. Presumably the main implication of this stability in yields under the adoption of new rice varieties is that new rice varieties had little effect on yield if the conditions set forth for growing rice were not satisfied. In other words a significant increase in rice yield from adopting the new varieties can only be attained if there is an assured water supply to irrigate the farms when necessary and proper management in the use of operating inputs, and if damage by typhoons, pests and diseases is minimized.

An attempt will be made in Chapter 4 to explain the yield variability between location within year, for the 1970 wet and dry seasons, by the use of regression analysis.

TABLE 29

THE MANN-WHITNEY "U" TEST TO TEST THE SIGNIFICANT DIFFERENCE BETWEEN MEANS OF TWO INDEPENDENT GROUPS, IN THREE SELECTED AREAS IN LAGUNA, PHILIPPINES, WET SEASON, 1966-71

Assigned level of significance (α) = .01

Year/Location	Yield (cavan/ha)	U-statistics[1]	Z-value[2]	Level of significance (α) associated with Z-value	Accept or reject null hypothesis (H_0)
1966 Biñan	44				
		257.5	-7.023	.00003	Reject
Cabuyao	50	304.0	-6.383	.00003	Reject
		624.5	-5.311	.00003	Reject
Calamba	68				
1967 Biñan	51				
		318.5	-8.880	.00003	Reject
Cabuyao	84	1601.0	-3.398	.0005	Reject
		294.0	-9.995	.00003	Reject
Calamba	80				
1968 Biñan	67				
		53.5	-4.918	.00003	Reject
Cabuyao	72	271.5	-0.913	.1814	Accept
		67.5	-5.949	.00003	Reject
Calamba	85				
1969 Biñan	54				
		397.5	-8.789	.00003	Reject
Cabuyao	93	849.5	-6.329	.00003	Reject
		2425.5	-1.067	.1446	Accept
Calamba	88				
1970 Biñan	59				
		428.0	-8.370	.00003	Reject
Cabuyao	68	862.5	-6.464	.00003	Reject
		81.5	-11.780	.00003	Reject
Calamba	99				
1971 Biñan	35				
		373.0	-7.210	.00003	Reject
Cabuyao	62	384.5	-6.148	.00003	Reject
		1467.5	-2.558	.0052	Reject
Calamba	76				

1. U-statistics is used to test homogeneity of two groups.
2. Z measures the significance of U terms in normal distribution.

TABLE 30

THE MANN-WHITNEY "U" TEST TO TEST THE SIGNFICANT DIFFERENCE BETWEEN MEANS OF TWO INDEPENDENT GROUPS, BY YEAR, THREE SELECTED AREAS IN LAGUNA, PHILIPPINES, WET SEASON, 1966-71

Assigned level of significance (α) = .01

Year/Location		Yield (cavan/ha)	U-statistics[1]	Z-value[2]	Level of significance (α) associated with Z-value	Accept or reject null hypothesis (H_0)
Binan	1966	44				
			456.5	-5.975	.00003	Reject
	1967	51	567.0	-0.671	.2514	Accept
	1968	67				
			444.0	-1.8186	.0344	Accept
			1549.0	-0.990	.1611	Accept
	1969	54				
	1970	59				
			623.5	-4.3757	.00003	Reject
	1971	35				
Cabuyao	1966	50				
			500.5	-7.460	.00003	Reject
	1967	84				
	1968	72	942.5	-0.400	.3446	Accept
			893.5	-1.069	.1423	Accept
	1969	93				
	1970	68	894.0	-7.924	.00003	Reject
			2665.0	-0.978	.1635	Accept
	1971	62				
Calamba	1966	68				
			561.0	-7.571	.00003	Reject
	1967	80				
	1968	85	1024.0	-1.563	.0594	Accept
			844.0	-2.256	.0119	Accept
	1969	88				
	1970	99	957.0	7.782	.00003	Reject
	1971	76	1665.0	3.413	.0003	Reject

1. U-statistics is used to test homogeneity of two groups.
2. Z measures the significance of U terms in normal distribution.

CHAPTER 4

THE RELATIONSHIP BETWEEN THE FACTORS OF PRODUCTION AND RICE YIELD

The persistently low productivity of rice in the Philippines makes the analysis of factors affecting rice yield important. The studies quoted in Chapter 1 section 1.2, led to formulation of the hypothesis that yield was substantially influenced by the factors of (a) rice variety, (b) amount of fertilizer, insecticide and other operating costs used, (c) quality of irrigation and (d) natural disasters or "acts of God" (e.g. typhoon, flood, drought, and insect infestation).

This chapter deals with the analysis of rice yield for both the wet and dry seasons of 1970.

4.1 The Production Function Model

The model used for this investigation was a power function (see section 2.6, Chapter 2) of the Cobb-Douglas form

$$Yc = a_0, a_1, a_2 \prod_{i=1}^{5} X_i^{b_i} e_j$$

When Y refers to the yield in cavans per hectare, a_0 is the overall intercept in logarithmic form, a_1 is the dummy variable for rice variety, a_2 is the dummy variable for the quality of irrigation, X_1 is the pre-harvest labour per hectare in man/days, X_2 is the elemental nitrogen in kilograms per hectare, X_3 is the operating cost in pesos per hectare (i.e. insecticides, weedicides, etc. except fertilizer cost and hired labour costs). X_4 is the total rainfall in millimeters, X_5 is the total solar energy in g-cal/cm^2 for 45 days before harvest b_1 to b_5 are the coefficients that define the transformation ratio when X_1 to X_5 are at different magnitudes and e_j represents the least squares residuals or random errors.

Although the function is non-linear, it can easily be transformed into a linear function by converting all variables to logarithms (Klein, 1962). In logarithms the associated linear function is

$$Y_c = A_0 + A_1 + A_2 + \sum_{i=1}^{5} b_i X_i + E_j$$

Since this becomes a linear function, least squares procedures may be applied to find the coefficients.

Using the (OLS) ordinary least squares programs of the UNIVAC 1108, the original observations were first transformed into logarithms. Transforming the observed data into logarithms would imply that the effects are known to be proportional instead of additive. Snedecor (1966) observed that in most economic data proportional effects are common, hence use of logarithms may correct serious cases of non-additivity. After converting the data to logarithms, the above linear function was determined.

4.2 Dummy Variables

Dummy variables were introduced because the phenomena in question could not be measured but only counted. This is true of all qualitative characteristics of objects, people, time periods, etc. The observation then consists of noting whether a certain characteristic is or is not present. In this study a value of 1 is assigned to the new, high-yielding rice varieties, and 0 to the local, low-yielding varieties. Any other two values may, however, be chosen to represent the presence and the absence of a given attribute (Kmenta, 1971).

Dummy variables or specifically zero-one variables were introduced into the regression equation to allow for variety and quality of irrigation effects. Effects of dummy variables, as shift variables of the Y-intercept, are discussed in sections 4.7.7 and 4.7.8.

4.3 Statistical Assumptions of the Least Squares Model

In the least squares approach, statistical assumptions must be considered. This is important for, if these assumptions hold true, the least squares estimates of the production function parameters will be unbiased and of minimum variance.

These assumptions, which are taken to apply to all observations, are as follows: (1) homoskedasticity, (2) non-autoregression, and (3) non-multicollinearity.

The first assumption concerning homoskedasticity implies that the variance of the disturbance is constant for all observations. In terms of our production function example, the assumption of homoskedasticity implies that the variation in output is the same whether the quantity of labour is 20, 100 or any other number of units.

The consequence of using the least squares estimator of the regression coefficient when the assumption of homoskedasticity is not satisfied, is that then the confidence limits and the test of significance of the coefficients do not apply. This means that inferences about the population coefficients are incorrect - that is, the calculated confidence intervals and acceptance regions are wrong (ibid). In this study, it is assumed that the variance of the disturbance is constant for all observations.

The second assumption requires that the disturbances be non-autoregressive. Under this assumption the fact that, say, output is higher than expected today, should not lead to a higher (or lower) than expected output tomorrow. This implies that the disturbance occurring at one point of observation is not correlated with any other disturbance.

In regression analysis, it is assumed that the stochastic error term (or the regression disturbance) ε_i is an independent random variable. ε_i serves as a catch-all variable and includes all effects other than the X_i

which are explicitly included in the regression function. For example, let Y_i be yield and X_i be area planted, and $Y_i = A + B X_1 + \varepsilon_i$. Then ε_i would represent, among other things, the effects of variables other than X_1 (area planted), which would include labour, operating costs, etc. (Yamane, 1967, p. 810). In this analysis of rice yield ε_i represents the effects of the variables other than area planted, pre-harvest labour, dummy variable for rice variety, elemental nitrogen, operating cost, dummy variable for quality of irrigation, total rainfall and total solar energy, and this variable would include also the level of management, soil type, etc. The relative low coefficient of determination (R^2) shown in Tables 31 and 32, although significant, shows that the 'unexplained' variation if considerable.

In many cases in business and economic data, there is a possibility that the ε_i may not be independent, and when the ε_i are not independent and show a serial correlation, the method of least squares may not give us the best estimates (that is, estimates with minimum variance). Second, the sampling variances of the regression coefficients that were found may seriously underestimate the true variance. Furthermore, the t and F - distribution to test the hypothesis or construct confidence intervals will not be used. It is therefore necessary that the assumption of independent ε_i is satisfied.

The least squares regression was fitted on the samples to test the hypothesis (1) of this study. When fitting this regression function, it was assumed that the stochastic error term ε_i was independent. To determine whether or not this assumption was valid, the data in this study were checked using the widely used econometric technique known as the Durbin-Watson test. The details of this test are given by Durbin-Watson (1951), Yamane (1970) and Kmenta (1971). In this study the Durbin-Watson Statistic (d) was calculated by the computer. This (d) value is then compared with the critical

TABLE 31

REGRESSION ELASTICITIES AND RELATED STATISTICS OBTAINED FROM THE COBB-DOUGLAS PRODUCTION FUNCTION ANALYSIS OF RICE YIELD IN THREE SELECTED AREAS, LAGUNA, PHILIPPINES, WET SEASON, 1970

Items	Location		
	Biñan	Cabuyao	Calamba
Number of observations	49	99	53
Coefficient of multiple determination (R^2)	0.299***	0.316****	0.418****
F-values (d.f.)	2.913	6.000	4.614
	(6,41)	(7,91)	(7,45)
Durbin-Watson Statistics	2.051	2.143	1.738
Intercepts in log form (ai)			
Over-all intercept (a0)	-8.50427	-0.61129	4.06723
	(7.11612)	(2.07836)	(9.05034)
Dummy variable for rice variety (a1)	a.	0.05683	0.08728
		(0.10531)	(0.08768)
Dummy variable for quality of irrigation (a2)	0.27548*	0.29578****	0.33522**
	(0.19450)	(0.10074)	(0.19410)
Regression elasticities (bi)			
Preharvest labour (b1)	0.11105	-0.02552*	0.03449
	(0.19267)	(0.12459)	(0.13275)
Elemental nitrogen (b2)	0.01163	0.04699	0.14415****
	(0.08193)	(0.07179)	(0.05278)
Operating costs (b3)	0.35377*	0.26284***	0.34642***
	(0.23651)	(0.10136)	(0.14575)
Total rainfall (b4)	-0.26174	0.03006	-0.35636**
	(0.25591)	(0.136568)	(0.18552)
Total solar energy (b5)	1.26198***	0.30001**	0.02808
	(0.61537)	(0.15995)	(0.82968)

Notes: a. In Biñan, dummy variable for rice variety was not included as one of the regressors because all the sample farmers reported plantings of new varieties. The figures in parentheses are standard errors.

**** Significant at 1 per cent level of significance.

*** Significant at 5 per cent level of significance.

** Significant at 10 per cent level of significance.

* Significant at 20 per cent level of significance.

TABLE 32

REGRESSION ELASTICITIES AND RELATED STATISTICS OBTAINED FROM THE COBB-DOUGLAS PRODUCTION FUNCTION ANALYSIS OF RICE YIELD IN THREE SELECTED AREAS, LAGUNA, PHILIPPINES, DRY SEASON, 1970

Items	Location		
	Biñan	Cabuyao	Calamba
Number of observations	13	57	54
Coefficient of multiple determination (R^2)	0.684	0.579****	0.335****
F-values (d.f.)	2.169	9.645	3.308
	(6,6)	(7,49)	(7,46)
Durbin-Watson Statistics	1.432	1.830	2.131
Intercepts in log form (ai)			
Over-all intercept (a0)	10.39501*	-3.99681	5.42229
	(5.70051)	(5.57036)	(6.44441)
Dummy variable for rice variety (a1)	a.	0.10595	0.13277
		(0.15931)	(0.10384)
Dummy variable for quality of irrigation (a2)	0.26521	2.10509****	0.28680
	(0.20535)	(0.29609)	(0.26747)
Regression elasticities (bi)			
Preharvest labour (b1)	-0.81760	0.050102	0.09947
	(0.51526)	(0.23245)	(0.11237)
Elemental nitrogen (b2)	0.75336***	0.23266*	0.08930*
	(0.26270)	(0.16974)	(0.05794)
Operating costs (b3)	-1.66261**	-0.13363	0.09707
	(0.70197)	(0.18519)	(0.10574)
Total rainfall (b4)	0.38463*	0.12896	0.22159****
	(0.26356)	(0.19426)	(0.06889)
Total solar energy (b5)	-0.04514	0.48470	-0.36854
	(0.34702)	(0.47942)	(0.65824)

Notes: a. In Biñan, dummy variable for rice variety was not included as one of the regressions because all the sample farmers reported plantings of new rice varieties. The figures in parentheses are standard errors.

**** Significant at 1 per cent level of significance.

*** Significant at 5 per cent level of significance.

** Significant at 10 per cent level of significance.

* Significant at 20 per cent level of significance.

Durbin-Watson values, d_L and d_U, which are given in tables contained in the above three references for 5, 2.5 and 1 per cent levels of significance.

The test assumes the following form:

H_0 : the null-hypothesis, idicates the absence of positive autoregression.

H_A : the alternative hypothesis, indicates the presence of positive autoregression.

When d is less than d_L, the d is significant and we accept the alternative hypothesis that there is presence of positive autoregression. When d is greater than d_U, the d is not significant and we accept the null hypothesis that positive autoregression is absent.

But when d is less than d_U but more than d_L, the test is inconclusive. If the result of the test is inconclusive, we may or may not draw conclusions. Using the 5 per cent level of significance in this study, the result of the test is illustrated in Table 33.

Note, however, that the value of d at k' equals 7 is compared to the table of critical values for d_L and d_U at k' equals 5, which is the maximum number of explanatory variables excluding the constant term, that the Durbin-Watson test can take.

Supposing the table is extended to k' equals 8, than the critical values of d_L will diminish while d_U will increase. This will therefore widen the boundary region of d_L and d_U. Because of the widening of the boundary region of d_L and d_U, the results of the test would tend to show more inconclusive answers than the previous test using k' equals 5.

Going back to the results in Table 33, it is shown that equations during the wet and dry seasons revealed absence of positive autoregression, except in one equation which is inconclusive.

In this case, the least squares estimates can be retained without fearing a loss of efficiency and bias of the estimated standard errors

TABLE 33

DURBIN-WATSON TEST FOR NONAUTOREGRESSION IN THREE AREAS, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Season/ Location	Number of		d Statistics	5% level of significance		Absence or presence of autoregression
	Observations (n)	Independent variables (k')		d_L	d_U	
Wet Season						
Biñan	48	6	2.051	1.34	1.77	Absence
Cabuyao	99	7	2.143	1.57	1.78	Absence
Calamba	53	7	1.738	1.38	1.77	Inconclusive
Dry Season						
Biñan	13	6	1.432	0.56	1.21	Absence
Cabuyao	57	7	1.830	1.38	1.77	Absence
Calamba	54	7	2.131	1.38	1.77	Absence

Finally the third assumption of the classical normal linear regression model is that none of the explanatory variables is too highly correlated with any other explanatory variable. When this assumption is violated, there exists multicollinearity. On the other hand, whenever all explanatory variables are uncorrelated with each other, there is an absence of multicollinearity. The cases in between are described by various degrees of multicollinearity. Multicollinearity, therefore, is a question of degree and not of kind. Hence, we do not 'test for multicollinearity', but if possible measure its degree in any particular sample.

If multicollinearity is encountered the estimated coefficients may be unreliable; variances may be large and the acceptance region for the hypothesis, that a given regression coefficient is zero, will be wide. In turn, this means that the power of the test is weak. Thus the test is not very helpful in discriminating between true and false hypotheses (*ibid.*, p. 391). The respective b coefficients will lack significance even when the R^2 is extremely high. In this case the equation may be used for predictive purposes, but the contribution of the changes in independent variables to the changes in the dependent variable can not be explained. In multiple regression analysis, it is always useful to examine the simple correlations between the independent variables to see whether or not multicollinearity is a problem. Respecification of the model, omitting one of the highly correlated variables, may then help to circumvent the problem of multicollinearity.

In this study, partial correlation coefficients between independent and dependent variables were computed by the UNIVAC computer for three locations and for both the wet and dry seasons. The correlation coefficients between independent variables are used as an indicator of the possible presence of linear or near linear relations among these variables. These coefficients are presented in Tables 34 to 39.

Heady and Dillon (1961) mentioned that if the correlation coefficients are close to plus or minus one, say greater than plus or minus 0.8, the regression analysis should be carried through with one of the highly correlated variables omitted. Which variable(s) to omit and which to retain should be decided on the basis of the logic--physical, biological, or economic--relevant to the production process being examined.

In this study, the highest positive and negative correalation coefficients among the independent variables observed are 0.5983 in Table 37 and -0.6560 in Table 35 respectively, it is therefore concluded that high multicollinearity is absent in this analysis.

From the above results we may confidently draw conclusions from the parameters estimated through the least squares method.

TABLE 34

CORRELATION (R) MATRIX FOR REGRESSION EQUATION OF RICE YIELD IN BIÑAN, LAGUNA, PHILIPPINES, WET SEASON, 1970

Variable	a_1	a_2	X_1	X_2	X_3	X_4	X_5	Y_c
a_1	a.							
a_2		1.0000	-0.0801	0.0562	0.0350	-0.2829	-0.0096	0.2453
X_1			1.0000	0.1294	0.1022	-0.0774	0.1035	0.1313
X_2				1.0000	0.2837	-0.1931	0.0291	0.1420
X_3					1.0000	0.0555	-0.0630	0.1971
X_4						1.0000	-0.5188	-0.3918
X_5							1.0000	0.4037
Y_c								1.0000

Note: a. In Biñan, dummy variable for rice variety (X3) was not included as one of the regressors, because all the sample farmers reported plantings of new rice varieties.

TABLE 35

CORRELATION (R) MATRIX FOR REGRESSION EQUATION OF RICE YIELD IN CABUYAO, LAGUNA, PHILIPPINES, WET SEASON, 1970

Variable	a_1	a_2	X_1	X_2	X_3	X_4	X_5	Y_c
a_1	1.0000	-0.2788	0.0377	-0.1461	-0.3814	0.1015	0.0264	-0.1507
a_2		1.0000	-0.1849	0.1170	0.5426	-0.0759	-0.0912	0.4504
X_1			1.0000	0.0219	0.0103	-0.0341	0.3015	-0.0143
X_2				1.0000	0.2945	-0.1155	0.1878	0.2089
X_3					1.0000	-0.1759	0.0656	0.4705
X_4						1.0000	-0.3916	-0.1298
X_5							1.0000	0.1791
Y_c								1.0000

TABLE 36

CORRELATION (R) MATRIX FOR REGRESSION EQUATION OF RICE YIELD IN CALAMBA, LAGUNA, PHILIPPINES, WET SEASON, 1970

Variable	a_1	a_2	X_1	X_2	X_3	X_4	X_5	Y_c
a_1	1.0000	-0.1129	0.0013	0.1710	-0.0920	-0.2218	0.0491	0.1943
a_2		1.0000	0.0352	0.0568	0.2472	0.0487	-0.1144	0.2696
X_1			1.0000	0.0604	0.0663	0.2761	-0.3758	-0.0062
X_2				1.0000	0.2961	0.0322	-0.0735	0.4449
X_3					1.0000	0.1688	-0.1337	0.3854
X_4						1.0000	-0.6560	-0.2524
X_5							1.0000	0.1097
Y_c								1.0000

TABLE 37

CORRELATION (R) MATRIX FOR REGRESSION EQUATION OF RICE YIELD IN BIÑAN, LAGUNA, PHILIPPINES, DRY SEASON, 1970

Variable	a_1	a_2	X_1	X_2	X_3	X_4	X_5	Y_c
a_1	a							
a_2		1.0000	0.1345	0.1631	0.0359	-0.1840	-0.0800	0.2422
X_1			1.0000	-0.2746	-0.4429	0.5983	-0.3704	-0.1803
X_2				1.0000	0.2944	-0.4163	0.1294	0.5773
X_3					1.0000	-0.0816	0.1575	-0.2020
X_4						1.0000	0.0430	-0.1705
X_5							1.0000	0.1986
Y_c								1.0000

Note: a. In Biñan, dummy variable for rice variety (X3) was not included as one of the regressors, because all of the sample farmers reported plantings of new rice varieties.

TABLE 38

CORRELATION (R) MATRIX FOR REGRESSION EQUATION OF RICE YIELD IN CABUYAO, LAGUNA, PHILIPPINES, DRY SEASON, 1970

Variable	a_1	a_2	X_1	X_2	X_3	X_4	X_5	Y_c
a_1	1.0000	0.2054	-0.2224	0.2053	0.0355	-0.2266	-0.0264	0.2172
a_2		1.0000	-0.2066	0.2235	0.0315	-0.0795	-0.0493	0.7378
X_1			1.0000	0.0229	-0.0370	0.2883	-0.0965	-0.1204
X_2				1.0000	0.5627	-0.1208	0.1613	0.2995
X_3					1.0000	-0.1650	0.1951	0.0433
X_4						1.0000	-0.5812	-0.0593
X_5							1.0000	0.0439
Y_c								1.0000

TABLE 39

CORRELATION (R) MATRIX FOR REGRESSION EQUATION OF RICE YIELD IN CALAMBA, LAGUNA, PHILIPPINES, DRY SEASON, 1970

Variable	a_1	a_2	X_1	X_2	X_3	X_4	X_5	Y_c
a_1	1.0000	-0.0573	0.0701	0.2939	0.0600	0.2094	-0.0013	0.3195
a_2		1.0000	0.1226	0.0296	0.2072	-0.0774	-0.1767	0.1519
X_1			1.0000	-0.0433	0.1410	-0.1317	0.0578	0.0878
X_2				1.0000	0.0266	0.1514	0.2237	0.2989
X_3					1.0000	-0.0482	0.1243	0.1460
X_4						1.0000	0.2114	0.4315
X_5							1.0000	0.0549
Y_c								1.0000

4.4 Statistical Significance

An overall test of the significance of the fitted regression model may be carried out by calculating the F ratio, regression mean square divided by error mean square. This ratio provides a test of the null hypothesis that all the regression coefficients are equal to zero. If the F value is larger than the tabled value of F at the desired probability level, the null hypothesis is probably not true (Heady and Dillon, 1961). On the basis of this F-test, all the values of the coefficient of multiple determination (R^2) were found to be significant in the areas studied. (R^2) value in the three areas during the wet season were highly significant only at the 5 per cent level while in Cabuyao and Calamba the R^2 were significant at 1 per cent level (Table 31). In the dry season, the R^2 of Cabuyao and Calamba were highly significant, while in Biñan it was not significant even at the 20 per cent level (Table 32).

The coefficients of multiple determination (R^2) indicate the percentage of the variance in yield accounted for by fitting the function. In this study, about 40 per cent of the variation in yield on the average, has been explained by the independent variables, for the three areas and for both the wet and dry seasons. The R^2 seems to be quite low, although statistically significant. However, such statistical significance merely denotes that there is some relationship between the independent and dependent variables. In production function research it is desirable that the coefficient of multiple determination (R^2) be as close to unity as possible in order to explain the major part of the response in terms of considered factors. There are thus likely to be other significant factors, apart from those already mentioned, which explain variations in yield. These could include land tenure problems, and it suggests the need for further study, possibly partitioning some of the variables along the lines of the landlord/tenant arrangements noted in Chapter 3, (Table 6).

Management, which is a most difficult input to measure, especially in cross sectional samples of farms, could probably explain why farmer A is getting higher yields than farmer B, when their farms have the same quality land, weather and use almost the same resources. In respect of land tenure it is recognised that an unsatisfactory landlord/tenant relationship in many parts of the world has resulted in a low incentive for both tenants and landlords to increase production. Conditions certainly vary between individual areas, but it seems advisable to undertake studies to determine what exactly are the undesirable features in the local landlord/tenant relationship which impede rice production in the Philippines.

Further studies would therefore be carried out to try and find these missing variables; only then when they are located can constructive efforts be made to improve the rice yield in the Philippines.

4.5 Elasticities

The regression results in the measurement of the relationships between the explanatory variable considered and rice yield are summarized in Table 31 and 32, for the wet and dry seasons respectively. The tables are organised in the following manner. The first column (1) is the list of variables and related statistics. The following columns show the values of statistical results obtained from the regression equation for each study area. As an illustration, if column (1) of Table 31 was written as a function, the equation would appear as follows:

$$Y_c = -8.50427 + 0.27548\ (X_1)^{0.11105}\ (X_2)^{0.01163}\ (X_3)^{0.35377}\ (X_4)^{-0.26174}\ (X_5)^{1.26198}$$

This equation indicates that the pre-harvest labour elasticity of the rice production is 0.1115: an increase in pre-harvest labour by 1 per cent would bring about an increase in the rice yield of about 11 per cent. And an increase in the operating costs by 1 per cent would lead to an increase in rice yield by 0.35 per cent.

Pre-harvest labour elasticity during the wet season is negative in Cabuyao while the elasticities in Biñan and Calamba are positive. Positive elasticities for pre-harvest labour were obtained in the dry season for Cabuyao and Calamba, and negative ones in Biñan. The elasticities of pre-harvest labour for both the wet and dry season and in the three locations are not significant except in Cabuyao which is significant at 20 per cent level.

Negative elasticities for pre-harvest labour imply a decrease in total product when pre-harvest labour is increased. The explanation for this negative elasticity for pre-harvest labour could be that there is a possibility of bias in recording, e.g. farmers with low yields or "poor farms" say that they work much longer hours than they actually do.

Elasticities of fertilizer are positive both wet and dry seasons and significant in four out of the six cases (Tables 31 and 32). Highly positive elasticity of fertilizer in Calamba for the wet season will possibly bring about an increase in yield with additional level of fertilizer application.

The regression elasticities of the operating costs are positive in the three locations during the wet season. Significant and positive elasticities of operating costs in the wet season will possibly bring about an increase in yield with additional operating costs of inputs. This is due to the fact that operating costs, which include insecticides, are more effective in increasing rice yield during the wet season when the percentage of crop damage due to the insect and pests is high (Table 40).

Elasticities of rainfall during the wet season are negative in Biñan and Calamba which indicates that excessive rain is also detrimental to the crop. In Cabuyao it is positive, but insignificant.

During the dry season, the elasticities of rainfall are all positive in the three areas. It is worthwhile to note that although Calamba has a relatively good irrigation system, it showed a highly significant positive elasticity for rainfall compared to Cabuyao and Biñan. This just proves that the irrigation system in Calamba is easily manageable, so that excess rainwater can easily be drained, thus creating a favourable environment for the growing rice plant.

Elasticities of solar energy are positive in the three areas during the wet season. The positive elasticity shows an increase in yield as solar radiation increases at a certain level of plant requirements during the dry season. This is especially true in Biñan where the elasticity is positive and highly significant.

In the dry season, however, the elasticities of solar energy show negative values in Biñan and Calamba. In Cabuyao, the elasticity is positive but not significant. In the dry season a negative response of yield to solar radiation could be expected, due to the fact that the solar energy was more than the plant required for optimum grain formation. At the present stage, however, no studies can be cited to support this point.

4.6 Mean Rice Yields and Factor Inputs

The rice yield per hectare and factor inputs for the wet and dry seasons in the three areas are shown in Table 40. The yield per hectare was highest in Calamba for both seasons, since the farms studied in Calamba were mostly under good irrigation (Table 8). The amount of pre-harvest labour per hectare was slightly higher in Calamba than in Cabuyao and Biñan for both seasons (Table 40).

An investigation of the causes of low yield in Biñan for both seasons shows that it was due to lack of water, since most of the farms were under the "poor" type of irrigation (Table 8). Lack of water was manifasted also in the percentage of area double-cropped: in Biñan, 27 per cent;

in Cabuyao, 62 per cent; and in Calamba, 95 per cent. Apart from the water problem, also a high percentage of the farms in Biñan reported crop damage due to typhoon, pest and diseases during the wet season (Table 40).

Differences in yield between the wet and dry seasons in all areas studied were also observed. In Calamba, where irrigation water is almost certain throughout the year, the output during the dry season is a little higher than that of the wet season crop. This could be due to the higher amount of solar radiation and a slightly higher amount of elemental nitrogen used during the dry season than in the wet season. Also reports of crop damage (Table 40) in per cent for the three locations are much higher in the wet than in the dry season.

An IRRI experiment conducted in the wet and dry season, 1967, by the Agronomy Department in farmers' fields in Calamba, showed a yield of 4.5 tonnes of rough (unmilled) rice to the hectare in the dry season for the same variety of rice planted. This shows an increase of approximately 53 per cent for the dry season crop over the wet season crop (IRRI, 1967). However, results of the farm survey in 1970 showed little difference in the average yield of rice in Calamba for the wet and dry season (Table 40). This could be explained by the fact that the IRRI experiment was conducted in a smaller area and was managed by an agronomist who had access to technical information on proper rice growing compared to the data obtained from the group of farmers who had varying levels of management and rice growing, gathered in a much wider area under different environmental conditions. This would imply that in practice, interpretation of results obtained from the experiment when applied in the farm situation should be discounted due to differences in management and environmental conditions existing between them.

TABLE 40

ARITHMETIC MEAN RICE YIELD AND VARIABLES THAT MIGHT EXPLAIN DIFFERENCES IN THE RICE YIELD IN THREE SAMPLE AREAS, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Items	Units	Location		
		Biñan	Cabuyao	Calamba
Wet Season				
Rice yield	(cavan/ha)	59.0	68.0	99.0
Area planted	(hectares)	4.03	2.38	1.79
Pre-harvest labour	(man/day/ha)	49.28	51.42	55.80
Elemental nitrogen	(kg/ha)	39.53	67.00	64.00
Operating cost	(pesos/ha)	380	492	329
Total rainfall	(mm)	1,047	1,109	988
Solar energy	(gm-cal/cm^2/ 45 DBH	15,066	14,591	15,824
Percent of farms reporting crops damaged	(%)	35	38	9
Dry Season				
Rice yield	(cavan/ha)	69.7	72.0	100.0
Area planted	(hectares)	2.57	1.77	1.32
Pre-harvest labour	(man/day/ha)	52.36	54.62	53.97
Elemental nitrogen	(kg/ha)	48.94	77.22	73.93
Operating cost	(pesos/ha)	328	453	320
Total rainfall	(mm)	320	337	277
Solar energy	(gm-cal/cm^2/ 45 DBH	27,231	23,193	22,874
Percent of farms reporting crops damaged	(%)	0	10	0
Percent area double-cropped	(%)	27	62	95

4.7 Relationship Between Rice Yield and Factors of Production : A Graphical Approach[10]

Yield curves were derived from the Cobb-Douglas production functions (Tables 31 and 32), to illustrate graphically the relationship between rice yield and the different factors of production mentioned earlier. Graphical

10. The tables of graphs are shown in Appendices E to I.

representations give us a good general picture of the 'shape' of the original data in the three areas studied during the wet and dry seasons.

Yield curve for each factor was obtained by holding other factors at their arithmetic mean. The arithmetic mean is employed here for it gives a measure of the general level of magnitude of the variable under consideration in the sense that, if we multiply the mean by the total number of observations, we get their aggregate values (i.e. $N\bar{X} = \Sigma X$, by definition) (Palasek, 1970, p. 67).

4.7.1 <u>Relationship Between Rice Yield and Pre-harvest Labour</u>

The estimated yield curves at specified levels of pre-harvest labour are indicated in Figure 5.

As indicated in section 4.5, the elasticities of pre-harvest labour are negative in Biñan during the dry and in Cabuyao during the wet seasons. Hence, the production curves showed a downward sloping curve for both locations and seasons.

On the other hand, production curves of Biñan during the wet and Cabuyao during the dry season showed an upward curve. Calamba has upward curves for both wet and dry seasons.

4.7.2 <u>Relationship Between Rice Yield and Elemental Nitrogen</u>

Nitrogenous fertilizer can be an important input with a direct effect on rice production. The estimated yield at several specified levels of elemental nitrogen is shown in Figure 6.

During the wet and dry seasons, all the estimated yield curves are upward sloping indicating that yield in these areas could be improved with an increased application of fertilizer.

4.7.3 <u>Relationship Between Rice Yield and Operating Costs</u>

The estimated yields as they are related to varying operating expenses, holding other factors of production at their arithmetic mean, are presented in Figure 7.

FIGURE 5

ESTIMATED RICE YIELD WITH VARYING PRE-HARVEST LABOUR - OTHER FACTORS HELD AT THE ARITHMETIC MEAN, BY LOCATION, AND BY SEASON, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

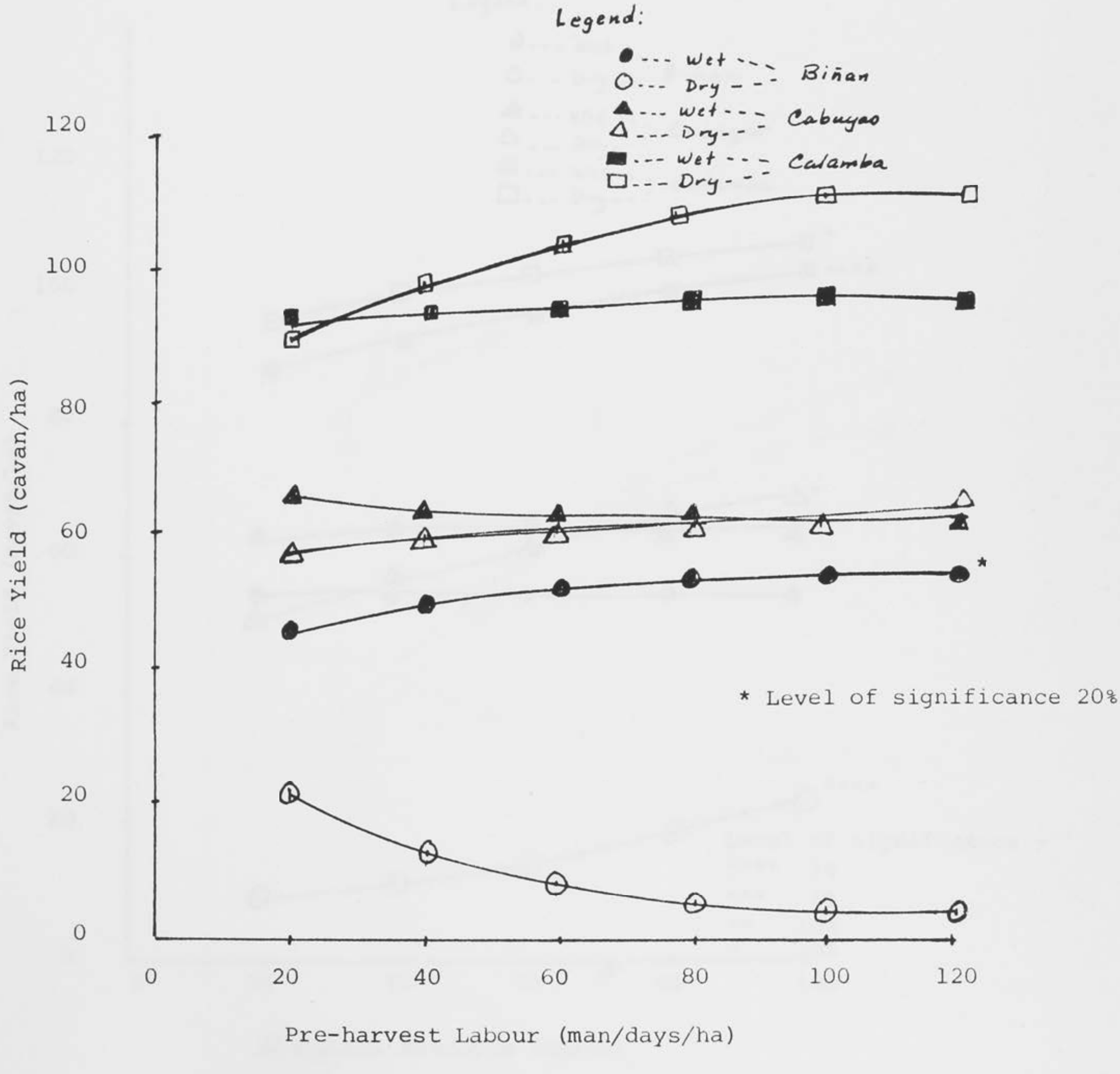


FIGURE 6

ESTIMATED RICE YIELD WITH VARYING ELEMENTAL NITROGEN APPLIED - OTHER FACTORS HELD AT THE ARITHMETIC MEAN, BY LOCATION AND BY SEASON, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

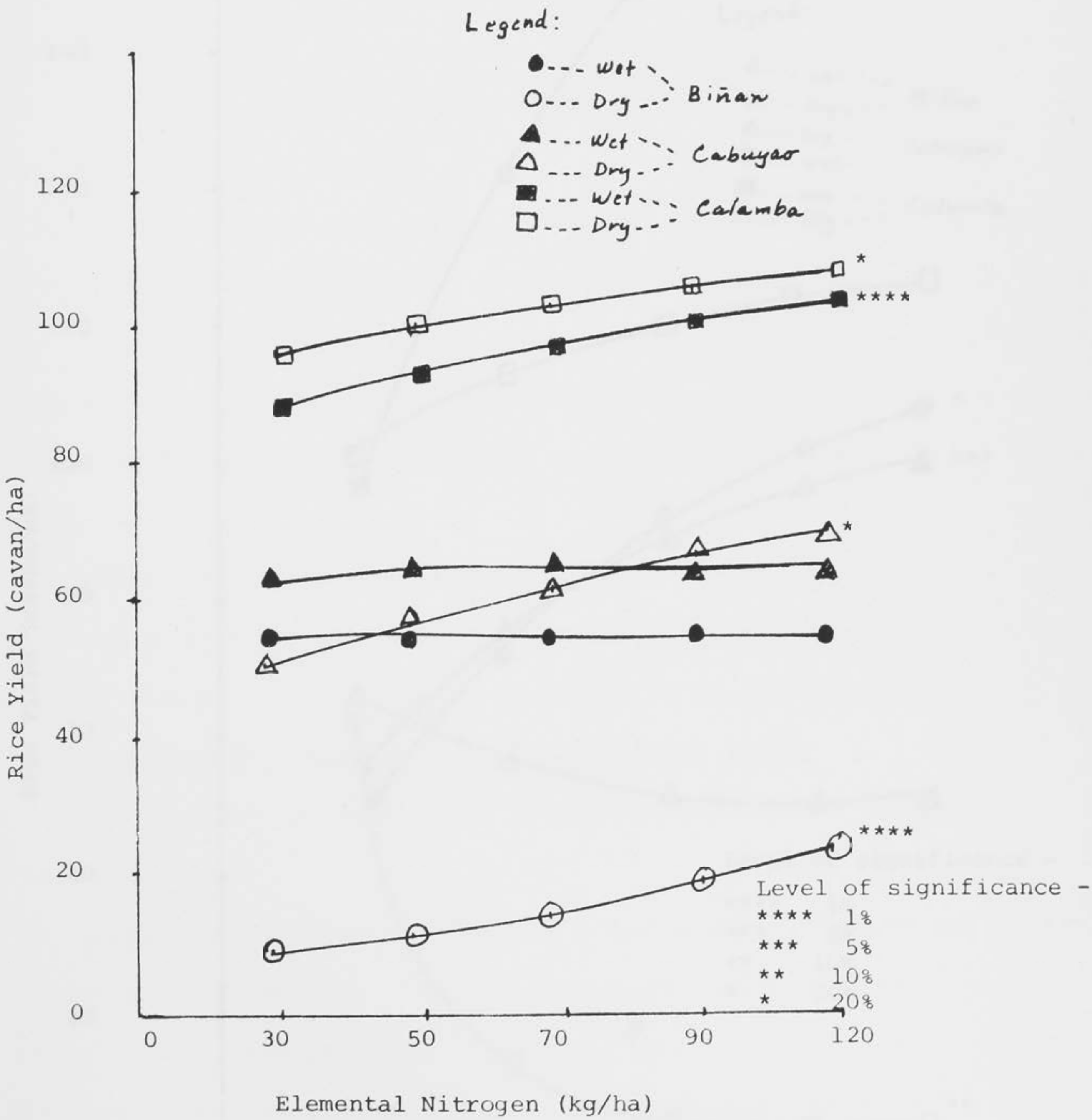
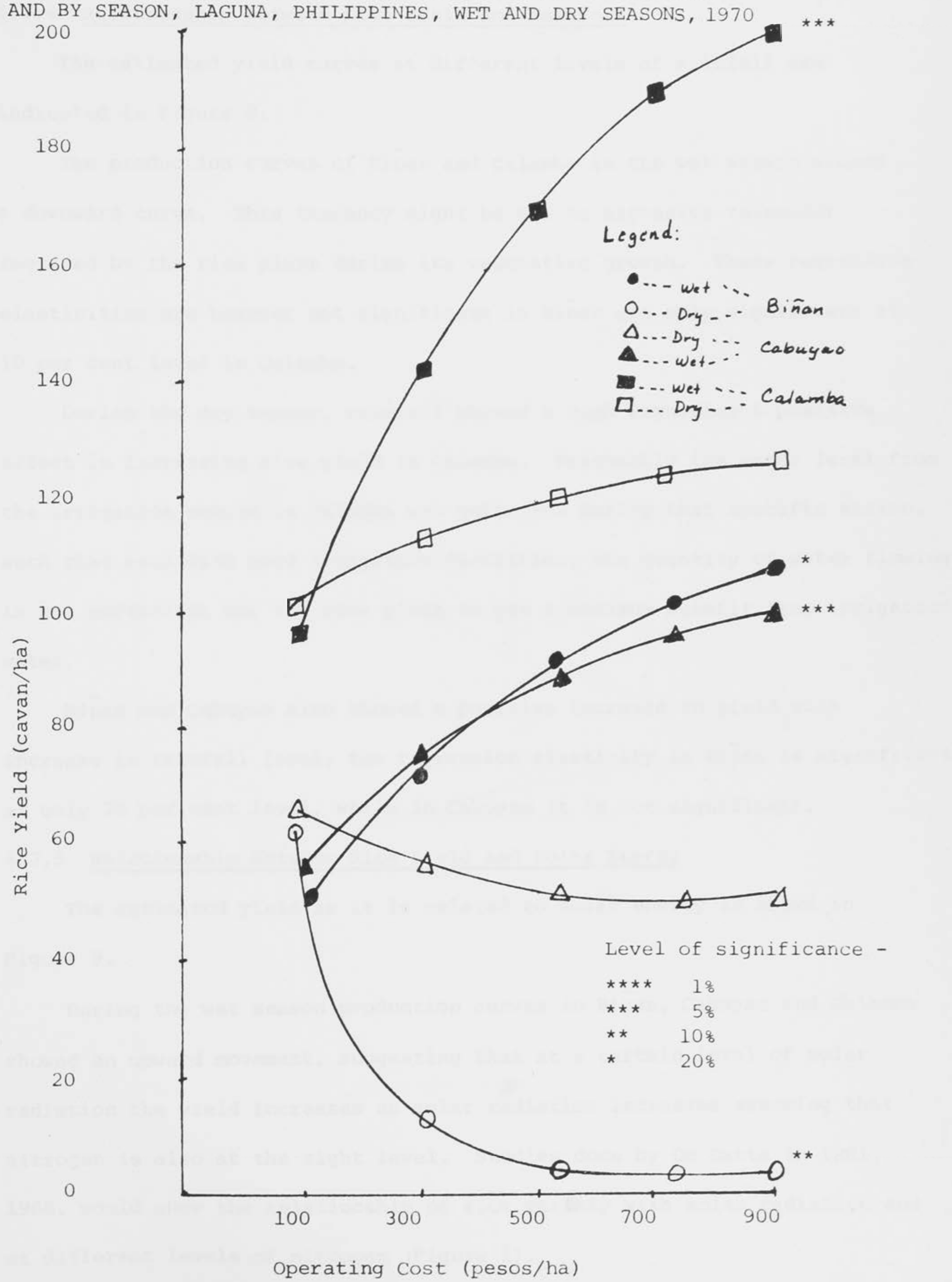


FIGURE 7

ESTIMATED RICE YIELD WITH VARYING OPERATING COST - OTHER FACTORS HELD AT THE ARITHMETIC MEAN BY LOCATION AND BY SEASON, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970



Five out of the six cases (Figure 7) showed an upward curve. This means that yield increases when cash operating expenses are increased.

4.7.4 Relationship Between Rice Yield and Rainfall

The estimated yield curves at different levels of rainfall are indicated in Figure 8.

The production curves of Biñan and Calamba in the wet season showed a downward curve. This tendency might be due to excessive rainwater required by the rice plant during its vegetative growth. These regression elasticities are however not significant in Biñan and only significant at 10 per cent level in Calamba.

During the dry season, rainfall showed a high significant positive effect in increasing rice yield in Calamba. Presumably the water level from the irrigation source in Calamba was quite low during that specific season, such that even with good irrigation facilities, the quantity of water flowing is not sufficient for the rice plant to get a maximum benefit from irrigation water.

Biñan and Cabuyao also showed a positive increase in yield with increase in rainfall level; the regression elasticity in Biñan is significant, at only 20 per cent level, while in Cabuyao it is not significant.

4.7.5 Relationship Between Rice Yield and Solar Energy

The estimated yield as it is related to solar energy is shown in Figure 9.

During the wet season production curves in Biñan, Cabuyao and Calamba showed an upward movement, suggesting that at a certain level of solar radiation the yield increases as solar radiation increases assuming that nitrogen is also at the right level. Studies done by De Datta in IRRI, 1968, would show the relationship of rice variety with solar radiation and at different levels of nitrogen (Figure 1).

Biñan and Calamba showed downward curves for dry season. However, the

FIGURE 8

ESTIMATED RICE YIELD WITH VARYING LEVELS OF TOTAL RAINFALL - OTHER FACTORS HELD AT THE ARITHMETIC MEAN, BY LOCATION AND BY SEASON, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

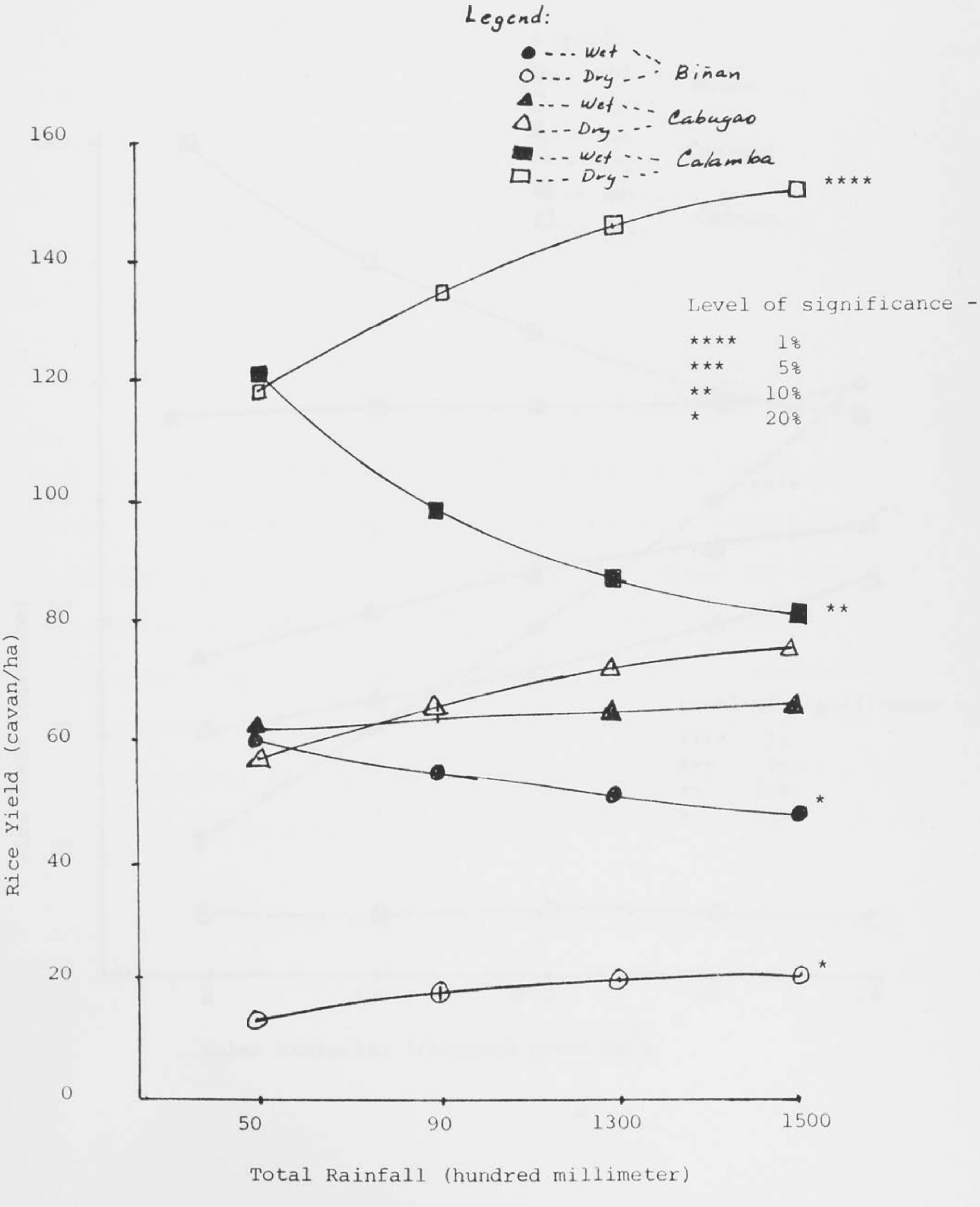
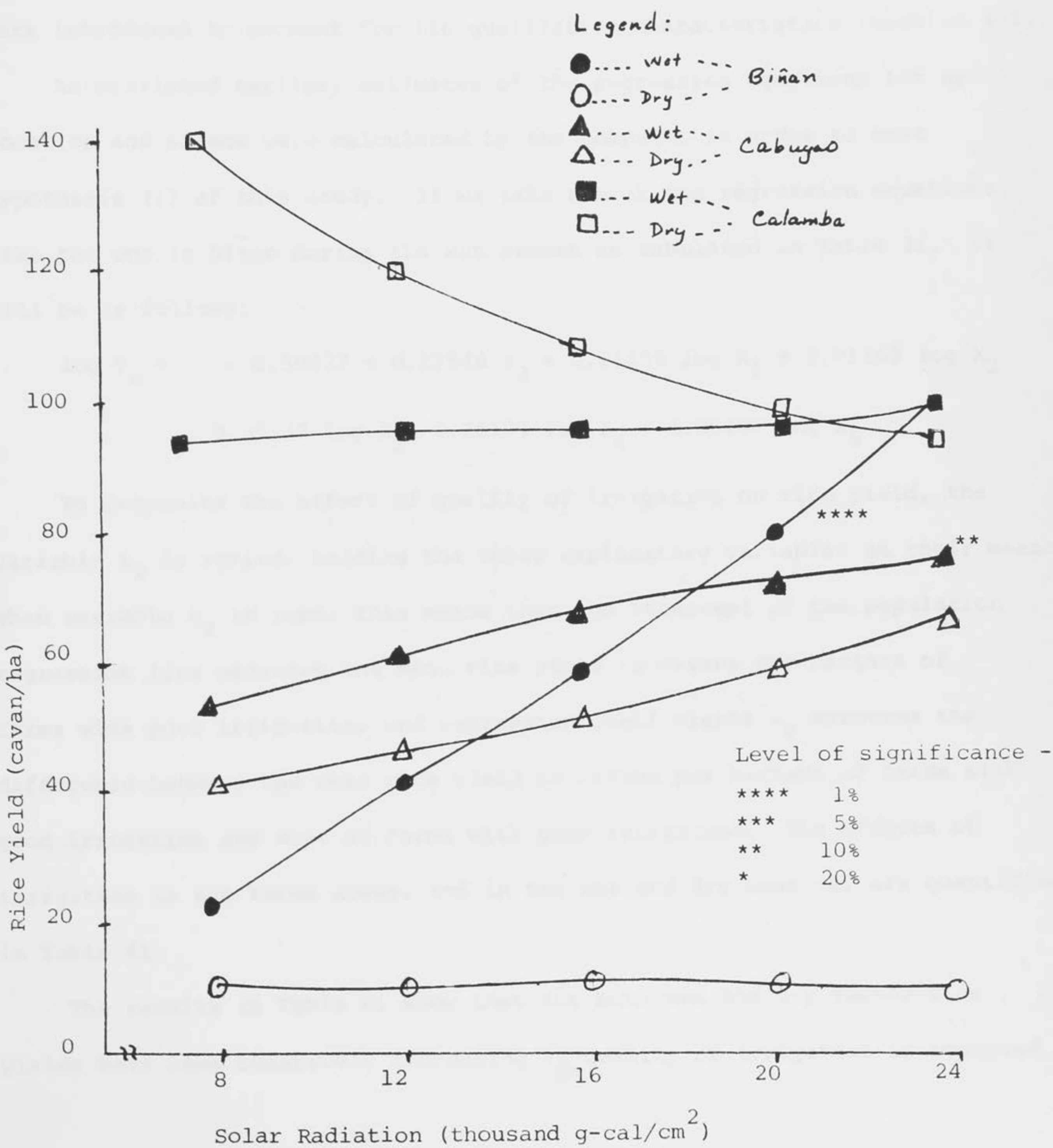


FIGURE 9

ESTIMATED RICE YIELD WITH VARYING LEVELS OF SOLAR RADIATION - TOTALS DURING THE LAST 45 DAYS BEFORE HARVEST - OTHER FACTORS HELD AT THE ARITHMETIC MEAN, BY LOCATION AND BY SEASON, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970



regression elasticities are not significant (section 4.5).

4.7.6 Effect of Quality of Irrigation on Rice Yield

As one would expect, irrigation is one of the most important factors in increasing rice yield. The effect of irrigation can not be measured directly, and so dummy variables on specifically zero-one variables were introduced to account for its qualitative characteristics (section 4.2).

As mentioned earlier, estimates of the regression equations for each location and season were calculated by the computer in order to test hypothesis (1) of this study. If we take one of the regression equations, like the one in Biñan during the wet season as tabulated in Table 31, it will be as follows:

$$\log Y_c = - 8.50427 + 0.27548\ a_2 + 0.11105 \log X_1 + 0.01163 \log X_2$$

$$+ 0.35377 \log X_3 - 0.26174 \log X_4 + 1.26198 \log X_5$$

To determine the effect of quality of irrigation on rice yield, the variable a_2 is varied, holding the other explanatory variables at their means. When variable a_2 is zero, this means that the intercept of the population regression line measures the mean rice yield in cavans per hectare of farms with poor irrigation, and regression coefficients a_2 measures the difference between the mean rice yield in cavans per hectare of farms with good irrigation and that of farms with poor irrigation. The effects of irrigation in the three areas, and in the wet and dry seasons, are quantified in Table 41.

The results in Table 41 show that for both wet and dry season rice yields have been relatively increasing as quality of irrigation is improved.

TABLE 41

EFFECT OF QUALITY OF IRRIGATION ON RICE YIELDS, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Item	Location		
	Biñan	Cabuyao	Calamba
Wet Season			
Yield - poor irrigation (0)	50.4	51.6	68.4
good irrigation (1)	95.1	102.1	148.4
Increase in yield due to improved irrigation (%)	89	98	117
Dry Season			
Yield - poor irrigation (0)	10.0	86.7	77.3
good irrigation (1)	18.3	110.4	149.6
Increase in yield due to improved irrigation (%)	83	27	150

4.7.7 Effect of Rice Variety on Rice Yield

As with quality of irrigation, the effect of rice variety on yield was measured by the use of dummy variable.

The increase in yield due to the adoption of the new varieties is shown in Table 42. Cabuyao and Calamba both showed an increase in rice yield in both seasons, if the rice variety planted was changed from local to new varieties. The effect of change in rice variety can not be shown in Biñan because all the farms reported plantings of new varieties.

TABLE 42

EFFECT OF RICE VARIETY ON RICE YIELDS, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Item	Location		
	Biñan	Cabuyao	Calamba
	(cavan/ha)		
Wet Season			
Yield - local variety (0)	-	61.1	97.7
new variety (1)	-	69.5	109.0
Increase in yield due to change from local to new variety (%)		14	12
Dry Season			
Yield - local variety (0)	-	57.5	91.4
new variety (1)	-	73.4	124.2
Increase in yield due to change from local to new variety (%)		28	36

To summarize briefly, the test of hypothesis (1) (section 1.3) of this study showed that approximately 40 per cent (average for the three locations and for both seasons) of the variance in yield (Y) was explained by the explanatory variables used. It is, therefore, proposed that in future work it would be helpful to include effects of management and other social factors which might be significant in explaining variability of rice yield in the three areas studied.

CHAPTER 5

EFFICIENCY OF RESOURCE USE IN RICE PRODUCTION

The second major hypothesis (section 1.3) of this study is that agricultural resources are being inefficiently utilized at the farm level.

5.1 The Efficiency of Resource Use Model

The typical approach to judging efficiency in cross-sectional samples has been to estimate a Cobb-Douglas type of production function and then using point estimates of the production elasticities, to make some statistical sampling theory test of equality between the estimated single-valued marginal value products and the marginal factor costs (Dillon and Anderson, 1971).

In this study, to obtain estimates and to compare the marginal productivities of different resources, the Cobb-Douglas type of production function was fitted to the observations in the three areas studies. The form of the function is as follows:

$$Y_f = a\, X_6^{b_6}\, X_7^{b_7}\, X_8^{b_8}\, E_j \qquad (1)$$

Where: Y_f = the farm income in a year measured in pesos

X_6 = is the total area planted in a year measured in hectares

X_7 = is the operating costs in a year measured in pesos per farm

X_8 = is the total man/labour in a year measured in man/days per farm

E_j = is the random disturbance or stochastic error term.

This function is also linear in logarithmic form as follows:

$$\log Y_f = \log a + b_6 \log X_6 + b_7 \log X_7 + b_8 \log X_8 + \log E_j$$

It should be noted, from section 2.7, that only three relevant variable resources (land, operating costs, and labour) were included in the analysis of resource productivity.

The production function was calculated using the method of ordinary least squares.

5.2 Statistical Assumptions of the Least Squares Model

In deriving the estimates of the regression parameters, the three basic assumptions underlying the classical normal linear regression model were used (see section 4.3). In this chapter, as in Chapter 4, the variance of the disturbance is assumed to be constant for all observations. This means that the disturbance has the same variance σ^2, whose value is unknown.

5.2.1 Test of Autoregression

Using the computer program of ordinary least squares, the Durbin-Watson statistic (d) were calculated and are presented in Table 43. This tested whether ε_i, the random disturbance in equation (1) showed autoregression or not. The Durbin-Watson statistics (d) were then compared to the Durbin-Watson critical values, d_L, and d_U, which are given in the table provided by Durbin and Watson for 5, 2.5 and 1 per cent levels of significance. These values vary with the number of observations (n) and the number of explanatory variables (k′) in the regression equation. A level of significance of 0.05 is used in this study, and the test is shown on Table 43.

From the table it is clear that positive autoregression is absent in all but one of the equations (for the location in Binān), which is inconclusive. With no autoregression, as indicated by the test, the least squares estimate presented in Table 45 can be retained without fear of obtaining ineffecient or biased estimated standard errors, and thus validates the use of t and F-distribution to test the hypothesis.

TABLE 43

DURBIN-WATSON TEST FOR NONAUTOREGRESSION OF THE SAMPLES IN THREE AREAS OF LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Location	Number of Observations (n)	Number of Independent variables (k')	d statistics	5 per cent level of significance d_L	5 per cent level of significance d_U	Absence or presence of autoregression
Biñan	41	3	1.418	1.34	1.66	Inconclusive
Cabuyao	59	3	1.880	1.48	1.69	Absence
Calamba	55	3	2.020	1.45	1.68	Absence

5.2.2 Measures of the Degree of Multicollinearity

The values of correlation coefficients for the independent variables in this study are presented in Table 44. In Biñan, the correlation coefficient between X_6 and X_7 is 0.8427, and that between X_6 and X_8 is 0.8356. These values seem too high and indicate a high degree of multicollinearity. Kmenta (1971) mentioned, however, that multicollinearity is regarded as harmful if, at say, the 5 per cent level of significance, the value of the F-statistic is significantly different from zero, but none of the t-statistics for the regression coefficients (other than the regression constant) is. From Table 45, in Biñan, the F-value is significantly different from zero and one of the three independent variables has significant t-statistics for regression coefficient. So following Kmenta's argument, it could be said that multicollinearity exists in the regression but that it is not 'harmful'; there is thus no reason why we cannot accept the hypothesis that there is a relationship between the dependent variable (Y_f) and the explanatory variables (X_6, X_7 and X_8).

In Cabuyao and Calamba, the correlation coefficients of the independent variables (X_6, X_7) and (X_6, X_8) also seem to be high. However, for the reasons explained, the hypothesis that there is a relationship between the dependent variable (Y_f) and the explanatory variables (X_6, X_7 and X_8) may still be accepted.

TABLE 44

CORRELATION (R) MATRICES FOR REGRESSION EQUATION OF RESOURCE PRODUCTIVITY IN THREE AREAS, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Variable	X_6	X_7	X_8	Y_f
(a) Binan				
X_6	1.0000	0.8427	0.8356	0.6999
X_7		1.0000	0.7950	0.7473
X_8			1.0000	0.6595
Y_f				1.0000
(b) Cabuyao				
X_6	1.0000	0.8789	0.9001	0.8679
X_7		1.0000	0.8469	0.8779
X_8			1.0000	0.7679
Y_f				1.0000
(c) Calamba				
X_6	1.0000	0.8904	0.8535	0.8585
X_7		1.0000	0.7845	0.8376
X_8			1.0000	0.7465
Y_f				1.0000

5.3 Statistical Significance

On the basis of the F-test, all the values of the multiple coefficient of determination (R^2) were found to be significant at the 1 per cent level (Table 45). The R^2 for the estimated functions were 0.81 in Cabuyao and 0.76 in Calamba, suggesting that the variations in the farm income from rice production is explained largely by the independent variables included in the equation. In Biñan, R^2 was only 0.56, suggesting that the regressors used in the equation had only explained a relatively small proportion of the variation in the dependent variable.

The elasticities of the three variable inputs indicate the percentage increase in farm income that would be realized with a 1 per cent increase in the indicated variable inputs. The elasticities were statistically examined in terms of the size of their standard errors. The hypothesis $b_i = 0$ (b_i was defined in section 2.6), is set up in each case and tested by a t-test. Five out of the nine elasticities presented in Table 45 are significant at the 5 per cent level or less. The significant elasticities are area in Cabuyao and Calamba, and operating costs in all three areas. All the significant coefficients are less than one, indicating decreasing marginal returns for each of the factors.

The statistically insignificant elasticities (man-labour) are also used in the analysis for reasons of economic logic. That is, production can not possibly go on without this input.

The negatively insignificant coefficient of man-labour in Cabuyao implies that either this variable probably did not influence farm income in the statistical analysis, or that the acceptance region for the hypothesis that a given regression coefficient is zero is wide; or that the power of the test was weak and thus not very helpful in discriminating between true and false hypotheses.

The sum of regression coefficients of inputs represents the return to scale or an indication of the extent of economies or diseconomies of scale.

In Biñan, the sum of elasticities is less than 1.0, indicating a decreasing return to scale; thus doubling of all inputs will cause output to expand less than twofold.

TABLE 45

REGRESSION COEFFICIENTS AND RELATED STATISTICS IN THREE AREAS, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Items	Location		
	Biñan	Cabuyao	Calamba
Number of observations	41	59	55
Coefficient of determination (R^2)	0.58 ****	0.81 ****	0.76 ****
F-value	17.332	76.132	56.646
Degrees of freedom	(3,37)	(3,55)	(3,51)
Durbin-Watson statistics	1.418	1.880	2.020
Value of intercept, in log form (a_0)	3.388331 ***	4.395967 ****	5.290647 ****
Value of elasticities (b_i)			
Area planted (X_6)	0.244538	0.720890 ****	0.613353 ****
	(0.293589)	(0.227421)	(0.209530)
Operating costs (X_7)	0.567324 ***	0.557662 ****	0.373510 ***
	(0.226908)	(0.141677)	(0.161754)
Man-labour (X_8)	0.095824	-0.183383	0.021477
	(0.209019)	(0.149422)	(0.150586)
Sum of elasticities	0.907686	1.095168	1.008340

The figures in parenthesis are standard errors.

*** Significant at 5 per cent level.

**** Significant at 1 per cent level.

In Cabuyao and Calamba, the sum of elasticities is greater than 1.0, indicating a slight tendency towards increasing return to scale; thus doubling all inputs will give rise to a more than twofold increase of output and decline in cost per unit. But this is under the assumption that no inputs have been excluded from the function.

5.4 Marginal Value Productivities

The marginal value productivities (MVPs) were derived from the elasticities of production using the geometric means[11] of inputs and outputs. The method used in arriving at the value of the MVPs has been presented in Chapter 2.

Marginal value productivities are simply the addition to farm income associated with the addition of one unit of a given resource, other resources being held constant.

The marginal value productivities estimated and the geometric means of their inputs are presented in Table 46.

The marginal value productivity of area planted was influenced by the natural conditions of the rice field such as soil type, solar radiation, rainfall, the size of area planted, etc. The value was highest in Calamba (₱1,253.76) followed by Cabuyao (₱983.89) and (₱314.10) in Biñan. High MVP in Calamba may be due to the smaller area planted and favourable environmental conditions enumerated above.

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11. Geometric means are commonly used for agricultural data, partly because the distribution of input and output is usually positively skewed. Hence the geometric mean, being closer to the mode is a more appropriate measure of the central tendency than the mean. Also, because of the log function, since the geometric mean is simply the arithmetic mean of the logs as shown below:

$$\text{G.M.} = \sqrt[N]{\prod_i^n X_i} = \frac{\sum_i^n \log X_i}{n}$$

TABLE 46

GEOMETRIC MEAN QUANTITIES OF OUTPUTS AND INPUTS AND MEAN OF MARGINAL VALUE PRODUCTS IN THREE AREAS, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Items	Units	Location		
		Biñan	Cabuyao	Calamba
Geometric mean of output	(₱/farm)	5,459	5,432	7.134
Geometric mean of inputs				
Area planted	(ha/farm)	4.25	3.98	3.49
Operating cost	(₱/farm)	1,588	1,926	1,164
Man-labour	(man/day/farm)	442	387	267
Marginal value products*				
Area planted	(₱/ha)	314.10	983.89	1,253.76
Operating cost	(₱/input cost)	1.95	1.57	2.29
Man-labour	(₱/day)	1.18	-	0.57

Note: * measured at the geometric mean level of inputs.

On the average, an additional peso spent on operating cost of inputs, X_5, would return 1.95 pesos in additional product in Biñan , 1.57 pesos in Cabuyao, and 2.29 pesos in Calamba, other inputs being held constant.

In Cabuyao, the negatively insignificant coefficient of man-labour (Table 45) made it impossible to get the geometric mean of MVP of labour. In general, marginal returns to man-labour are, unfortunately, not reliable but indicate very low marginal returns to additional input. This agrees with the generally held hypothesis that farms in most developing countries use relatively large proportion of labour compared to other inputs.

5.5 Efficiency of Resource Allocation

The efficiency criterion, as mentioned in the first page of this chapter, is arrived at through the concept of optimality. An optimum condition is achieved when the estimated single-valued marginal value product equals the marginal factor cost (MVP = MFC). Marginal value product (MVP) is simply the ratio formed by dividing total farm income by total input, multiplied by the elasticity figure (section 5.4). Marginal factor cost (MFC) refers to the cost of hiring one unit of the resource, or its price in alternative uses.

The market price of land, charged at 6 per cent of the value per hectare, has always been taken as the annual cost of renting one hectare since we are interested in land services rather than land per se. The opportunity cost of a peso of capital has been taken as one peso plus the relevant annual interest charge of 30 per cent. Labour is valued at 5.50 pesos per day, on the assumption that the employment of additional labour would imply the purchase of hired labour which is quoted to be the daily agricultural wage rate.

Table 47 shows MVPs and their corresponding factor costs. It also indicates the difference between the MVP and MFC for adjustments in the flow of resources. The differences between MVP and MFC are shown in columns (4), (7) and (10) of Table 47. The positive differences indicate that additional units of resource result in increased returns; added costs will be greater than added total revenue if the differences are negative. It is observed, that there are high returns for investment on land in Cabuyao and Calamba and positive differences in operating cost in all areas, although most differences are small. To determine whether there is a significant difference between the MVP and the MFC, the t-test of this form is used and calculated by computer. The formula may be written as follows:

$$t = \frac{MVP_{X_i} - MFC_{X_i}}{S_b \sqrt{n}}$$

where: $MVP_{X_i} = b_i \bar{Y}/X_i$ (See Chapter 2, on how to derive MVP from the elasticity of production)

$MFC_{X_i} = k'$ (The factor price, which is constant)

TABLE 47

MARGINAL VALUE PRODUCTS, MARGINAL FACTOR COSTS AND THEIR ESTIMATED DIFFERENCES IN THREE AREAS, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Location	Resources		
	Area planted	Operating cost	Man-labour
Biñan			
Marginal value product (MVP)	314	1.95	1.18
Marginal factor cost (MFC)	750	1.30	5.50
Difference (MVP -MFC)	-446	+0.65	-3.32
Cabuyao			
Marginal value product (MVP)	984	1.57	-
Marginal factor cost (MFC)	480	1.30	-
Difference (MVP -MFC)	+504	+0.27	-
Calamba			
Marginal value product (MVP)	1,254	2.29	0.57
Marginal factor cost (MFC)	615	1.30	5.50
Difference (MVP -MFC)	+539	+0.99	-4.93

Assuming that the original populations are not far from normal, the MVP_{X_i} $-MFC_{X_i}$ population is approximately normally distributed, and the null hypothesis that will be tested is H_0: $MVP_{X_i} = MFC_{X_i}$ which is equivalent to saying that MVP_{X_i} $-MFC_{X_i}$ equals 0.

The t-values for the test of differences between MVP_{X_i} and MFC_{X_i} are

are shown in Table 48. The test provides evidence to reject at the 1 per cent level of significance, the hypothesis that the marginal productivities of the three resources are significantly equal to their factor cost in the three areas studied, indicating that resources were utilized inefficiently.

TABLE 48

THE T-VALUES AND SIGNIFICANT LEVEL FOR THE TESTS OF DIFFERENCES BETWEEN MARGINAL VALUE PRODUCTIVITY AND MARGINAL FACTOR COST, LAGUNA, PHILIPPINES, WET AND DRY SEASONS, 1970

Resources	Location		
	Biñan	Cabuyao	Calamba
Area planted	-14.15 ****	-8.41 ****	11.00 ****
Operating cost	4.10 ****	4.34 ****	0.73 n.s.
Man-labour	-28.08 ****	-	- 37.16 ****

Notes: **** significant at 1 per cent level.
n.s. Not isgnificant.

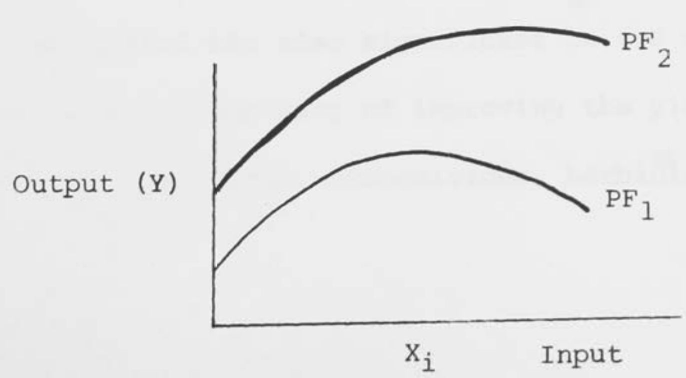
The results of the t-test in Table 48, together with the figures in Table 47 indicate that areas planted in Cabuyao and Calamba could be expanded to yield a greater product. The supply of land of this quality is however limited, and would mainly occur in marginal lands which have lower productivities (and different production function). The above table also shows that operating costs of inputs could be increased to yield a greater product under the existing technology. However, an interest charge of 30 per cent has been taken into account whilst rice farmers are also faced with very high risks and uncertainties due to drought, typhoon, insect and pest damage and the possibility of low prices of rice during harvest months. Under these circumstances the differences between the marginal products and the marginal costs of the operating cost of inputs (Table 47) may not be sufficient to provide an incentive for increasing the use of operating capital. This is particularly so in Cabuyao. In some cases too, the relevant interest charge may be at least 50 per cent.

On the other hand, the above results show that labour, at a quoted daily wage rate of hired labour, is being used inefficiently. In many instances, however, this assumption overvalues the opportunity cost of labour since additional family labour, which forms almost 70 per cent of the supply of labour force in the farm (Table 24) is available at a cheaper price or sometimes at a zero opportunity cost. If labour is assumed to have a low opportunity cost, then it is not being used inefficiently, in Biñan and Calamba.

The above findings suggest that policy makers must look into the possibility of achieving higher rice productivity through improvement in supportive services (i.e. credit and marketing facilities) which enable higher input levels to be met (and reflect in higher operating costs) without these being accompanied by greater risk and uncertainty. Improvement in irrigation facilities is also likely to further enhance the marginal value product of capital (as indicated by the situation in Biñan and Calamba - Table 47), and to minimize risk due to drought. Such improvement will, of course, mean that farms will operate on a different production function. Consider what happens for example to the production function where there is a change in technology (in this case an improvement in irrigation facilities). This is illustrated in Figure 10 below:

FIGURE 10

SHIFTING OF PRODUCTION FUNCTION DUE TO CHANGE IN TECHNONOGY: A THEORETICAL ILLUSTRATION



A shift from PF_1 to PF_2 (resulting for example from the improvement of irrigation facilities) shows that more output (Y) can be produced with less input X_i.

Often, improvement in irrigation facilities takes time and a large investment on the part of government, which is confronted at this stage of the economy with the problem of allocating the limited funds over a wide area.

So, for the meantime it is probably practical for policy makers to direct their policies at reducing risk through better supporting services as mentioned above. Further, steps must be taken to create conditions which will provide sufficient incentives and inducements to farmers to invest in progress. It is necessary to ensure that the implementation of new techniques by willing farmers is not frustrated through lack of inputs and finance. Fertilizers, pesticides and better seeds must be supplied on time, and the farmers must be given the necessary credit facilities so that they can make the required investments. Finally, it is necessary to ensure that the farmer is getting the proper reward he expects from investing in new techniques. This is related to the improvement of marketing facilities and the reasonable and stable prices for produce. There may also be a need for a policy of price stabilization in agriculture.

5.6 Possibility of Improving Rice Yield Through Increased Use of Fertilizer: A Partial Budgeting Technique

Elasticities of nitrogen are significant in four out of all cases (see Tables 31 and 32). Apart from this, the marginal value products of operating capital are also significant in two out of the three cases (Table 48). This shows the possibility of improving the yield of rice through additional inputs (e.g. fertilizer, insecticides, herbicides and so on). The use of insecticides and herbicides for the control of pests, diseases, and weeds is important and will undoubtedly increase in importance with the increased use of fertilizers following the introduction of the improved rice varieties. However, a high degree of variability in infestation levels plus a general lack of knowledge of response of yields to varying levels and frequencies of insecticide and herbicide use in the fields, makes it impossible to make a meaningful economic recommendation for these two inputs. Therefore, to simplify the discussion, fertilizer is used as an example in the partial budgeting technique that follows.

Partial budgeting has been a useful tool of economic analysis for agricultural scientists concerned with evaluating the economics of individual experiments or introducing innovations to farmers. A merit of this simple technique is that it can be understood by an ordinary farmer in measuring the efficiency of resource use than the concept of optimality (MVP = MFC) presented in section 5.5. This technique has been discussed at some length by Shastri (1962), Ruttan and Moomaw (1964), Baker (1970), Yang (1971) and others. Partial budgeting, in contrast to complete budgeting, is simple, for it focuses attention only on those inputs, products, and prices which are expected to change during the specified period. It provides a clear indication of the profitability of rice farming and sets forth a clear plan for utilizing a particular resource.

5.6.1 <u>Sources of Basic Data</u>

The accuracy and efficiency of preparing a partial budget depends largely on the quality of basic input-output data available to serve as basic materials. Basic data in respect to prices of the product and inputs are also necessary.

In this study, partial budgeting is developed from experimental data and from farm survey data.

Experimental data on nitrogen response of IR8 variety is based upon the experiment conducted in the 1970 dry season at IRRI, under the supervision of the Agronomy Department, IRRI. The farm data is based upon the survey conducted in the 1970 dry season at three locations, Biñan, Cabuyao, and Calamba, gathered by the Agricultural Economics Department, IRRI. Figures for new varieties were the only ones included.

5.6.2 Procedure in Partial Budgeting

The initial step in economic analysis by the partial budgeting technique is to estimate the response function by the least squares method. The regression analysis and its response curves for the experimental data and farm survey results are presented in Figure 11.

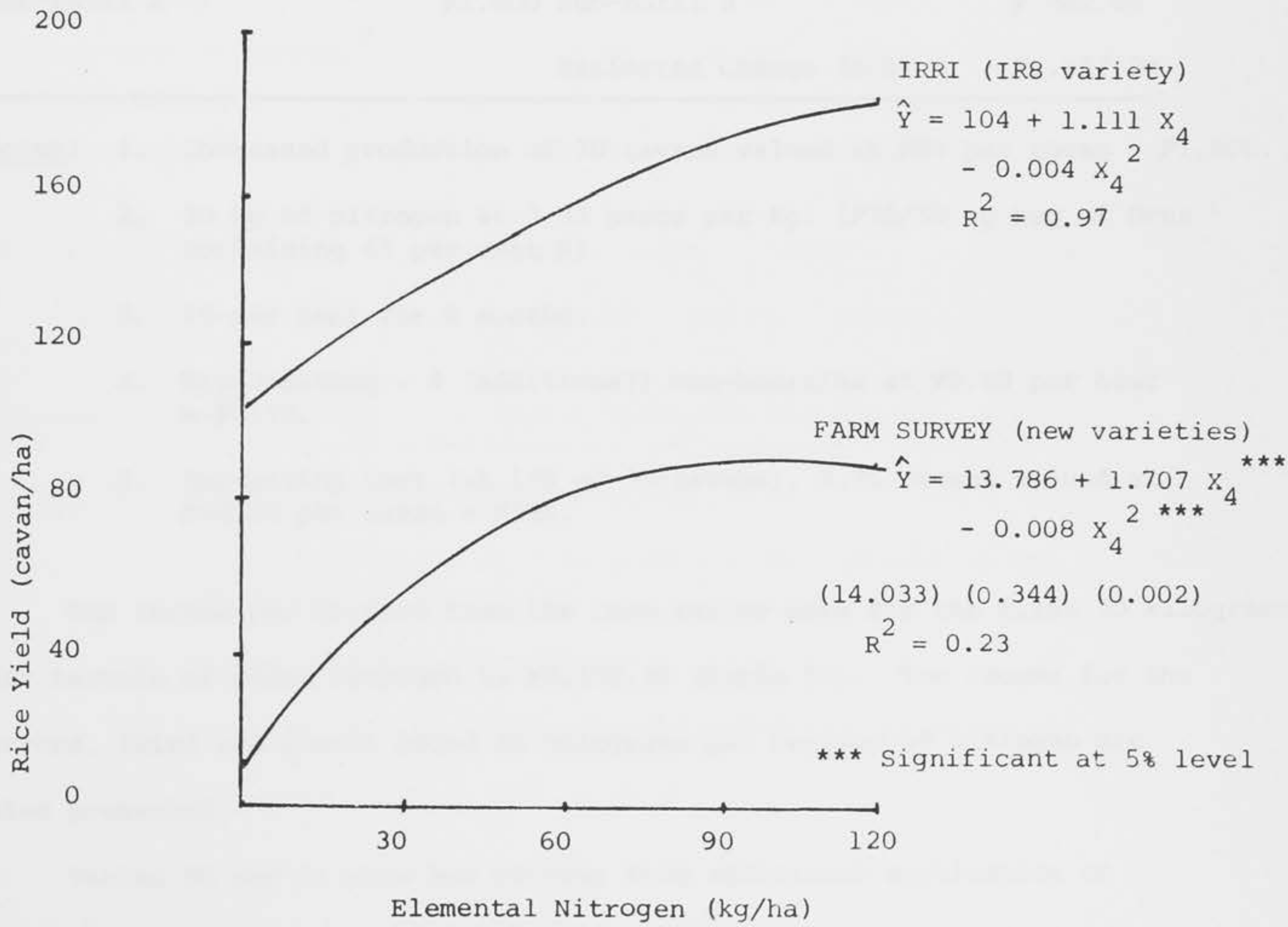
A quadratic equation was selected for reasons of economic logic. Ordinarily, results of experiments represented by crop response will have diminishing returns for all inputs greater than zero. The farm data used may not be the exact estimate of the yield response to nitrogen application because of the difference in the resource endowment in the three locations. However, it could still be used here for illustration purposes, although care must be taken in interpreting the results.

From the response equations, budgets were developed to show the changes in rice produced and additional fertilizer input (Table 49). The table is divided into four categories: (a) added returns, (b) reduced costs, (c) added costs, and (d) reduced returns. Items listed on the left side of the table increase income while those on the right side reduced income. Thus, the right side is added and subtracted from the left side to determine whether the new alternative being considered is more profitable (A-B is positive) or less profitable (A-B is negative) than the current practice.

Results of the budgeting showed that in experimental data, the increase in income per hectare for applying the first 30 kilograms of nitrogen

FIGURE 11

RICE YIELD RESPONSE TO NITROGEN BY SOURCES OF BASIC DATA, IRRI EXPERIMENT AND FARM SURVEY DATA IN THREE AREAS, LAGUNA, PHILIPPINES, DRY SEASON, 1970



is ₱1,457.38 (Table 49). For the second, third, and fourth added 30 kilograms, the incomes are shown in Table 50.

TABLE 49

APPLICATION OF 30 KG OF NITROGEN VERSUS NO FERTILIZER, IR8 VARIETY, DRY SEASON, IRRI, 1970

a. Added Returns		c. Added Costs	
Change in rice produced[1]	₱1,800	Fertilizer[2]	₱ 99.90
		Interest on capital[3]	14.98
		Application[4]	2.76
		Harvesting[5]	225.00
b. Reduced Costs		d. Reduced Returns	
None	-	None	-
Sub-total A	₱1,800	Sub-total B	₱ 342.64
		Estimated Change (A-B)	₱1,457.38

Notes: 1. Increased production of 30 cavans valued at ₱60 per cavan = ₱1,800.

2. 30 kg of nitrogen at 3.33 pesos per kg. (₱75/50 kg bag of Urea containing 45 per cent N).

3. 15 per cent for 6 months.

4. Broadcasting - 4 (additional) man-hours/ha at ₱0.69 per hour = ₱2.76.

5. Harvesting cost (at 1/8 of 30 cavans), 3.75 cavans valued at ₱60.00 per cavan = ₱225.

The income per hectare from the farm survey data for the first 30 kilograms per hectare of added nitrogen is ₱2,192.36 (Table 51). The income for the second, third and fourth added 30 kilograms per hectare of nitrogen are also presented.

Tables 50 and 51 show how returns from additional application of nitrogen vary between the experimental station and the farmers' fields. In the experimental farm, the net income from fertilizer application is still positive even if the level of application is raised to 120 kg/ha, whereas in the farmers' fields, the net income shows a negative value as the nitrogen level is increased from 60 to 90 kg/ha.

TABLE 50

EFFECTS OF APPLICATION OF NITROGEN AT DIFFERENT LEVELS, VARIETY IR8, DRY SEASON, DATA OBTAINED FROM IRRI EXPERIMENT, LAGUNA, PHILIPPINES, 1970

Items	Change in nitrogen level			(kg/ha)
	0-30	30-60	60-90	90 - 120
a. Added Returns				
Change in rice produced[1]	₱1,800	₱1,380	₱1,020	₱ 600
b. Reduced Costs	none	none	none	none
Sub-total A	1,800	1,380	1,020	600
c. Added Costs				
Fertilizer[2]	99.90	99.90	99.90	99.90
Interest on capital[3]	14.98	14.98	14.98	14.98
Application[4]	2.76	2.76	2.76	2.76
Harvesting[5]	225.00	172.50	127.50	75.00
d. Reduced Returns	none	none	none	none
Sub-total B	342.64	290.14	245.14	192.62
Estimated Changes (A-B)	₱1,457.38	₱ 1,089.86	₱ 774.86	₱ 407.38

Notes: 1. Rice is valued at ₱60 per cavan.

2. 30 kg of nitrogen at 3.33 pesos per kg. (₱75/50 kg bag of Urea containing 45 per cent N).

3. 15 per cent for 6 months.

4. Broadcasting - 4 (additional) man-hours/ha at ₱0.69 per hour.

5. Harvesting cost at 1/8 of added returns.

TABLE 51

EFFECTS OF APPLICATION OF NITROGEN AT DIFFERENT LEVELS, NEW VARIETIES DRY SEASON, DATA OBTAINED FROM FARM SURVEY IN BIÑAN, CABUYAO AND CALAMBA, LAGUNA, PHILIPPINES, 1970

Items	Change in nitrogen level			(kg/ha)
	0-30	30-60	60-90	90 - 120
a. Added Returns				
Change in rice produced[1]	₱2,640	₱1,740	₱ 120	₱ 60
b. Reduced Costs	none	none	none	none
Sub-total A	2,640	1,740	120	60
c. Added Costs				
Fertilizer[2]	99.90	99.90	99.90	99.90
Interest on capital[3]	14.98	14.98	14.98	14.96
Application[4]	2.76	2.76	2.76	2.76
Harvesting[5]	330.00	217.50	15.00	7.50
d. Reduced Returns	none	none	none	none
Sub-total B	447.64	335.14	132.64	125.12
Estimated Changes (A-B)	₱2,192.36	₱1,404.86	-₱12.64	-₱ 65.12

Notes: 1. Rice is valued at ₱60 per cavan.

2. 30 kg of nitrogen at 3.33 pesos per kg. (₱75/50 kg bag of Urea containing 45 per cent N).

3. 15 per cent for 6 months.

4. Broadcasting - 4 (additional) man-hour/ha at ₱0.69 per hour.

5. Harvesting cost at 1/8 of added returns.

The implication of this result is that in interpreting experimental results in order to make recommendations to farmers, one must consider factors like risk and uncertainty, which are of great importance to practising farmers, in order to arrive at a more realistic economic interpretation.

Based on the budgeting results presented above, the yield of rice per hectare can be increased, assuming other factors of production constant, with an additional level of nitrogen application at 60 kg/ha (based on farm survey data) or as high as 120 kg/ha if conditions prevailing in the farm are similar to those in the experimental station, where the information on rice yield response to nitrogen was taken.

This example demonstrates one practical use of research results. The contrast between controlled experiments and field results is sufficently great to encourage one to repeat the exercise for each area.

CHAPTER 6

SUMMARY AND CONCLUSION

In spite of the success in developing new high yielding rice varieties in the Philippines, the country is still troubled by the basic problem of insufficiency in rice. The national average rice yield remains relatively low compared to most Asian countries and the world average. To keep up with the domestic demand the Philippine Government has had to import rice, which has caused a drain on foreign exchange earnings. Coupled with the problem of low productivity in rice is the grave problem of rapid population increase, which has been estimated at an annual rate of 3.02 per cent, one of the highest population growth rates in the world.

This study focuses on the factors affecting the yield of rice, productivity and efficiency in the use of resources and the potential for increased productivity through adjustments of some resources under the existing technology in the three selected areas.

In order to understand the problem of low productivity in rice, the researcher must have information regarding the relationships of yield to (a) use of rice variety, (b) use of fertilizer and other inputs, (c) adequacy and reliability of the farmer's water supply, and (d) effects of natural disasters (e.g. typhoons, flooding, drought or insect infestation).

The specific objective of the study was to test the following hypotheses:

(1) That yield was substantially influenced by the factors of (a) rice, (b) the amount of fertilizer, insecticide and other inputs used by the farmer, (c) the adequacy and reliability of the farmer's water supply, and (d) natural disasters, (e.g. flooding and drought); and

(2) That agricultural resources are being utilized inefficiently, thus causing low productivity in the use of resources.

This study is divided into four major parts. The first deals with the research methodology used. The second part is a description of farms, revenue and costs, and comparison of rice yields by location and by year. This provides the necessary background for the subsequent economic analyses. The third part deals with the first hypothesis, that yield was substantially influenced by the factors enumerated above. The fourth part examines the productivity and efficiency of resource use in the three selected areas.

The study areas are Biñan, Cabuyao, and Calamba. These were chosen on account of the availability of comparable data relating to the pre- and post-adoption period of the new rice varieties. Since the areas are physically different from each other in terms of available resources, the study of the relationship between irrigation and productivity was possible.

The method used in collecting the data was through personal interview with the sample farm operators. The sample size was proportionally allocated to the sample barrios according to the population of rice farmers in each selected barrio. The sample farms were drawn at random with equal probability and without replacement. Results of the variances and means of the current sample, calculated by the use of the 'BASTATS' program on the UNIVAL 1108 computer, showed that for the three areas studied, the number of sample farms taken was sufficient to give a reasonable estimate for the population.

The analytical framework for testing hypothesis consists of (1) farm description and revenue and costs, (2) analysis of rice yield, and (3) analysis of the productivity and efficiency of resource use.

The analysis of rice yield dealt with factors affecting rice production. The factors considered were resources, technology and environment. Thus, the rice yield was formulated as a function of resources such as labour, dummy variable for rice variety, elemental nitrogen, operating costs, dummy for quality of irrigation, total rainfall, and total solar energy. The Cobb-Douglas type of production function was fitted statistically to the data by the method of least squares. This permitted the testing of the first hypothesis, that the factors enumerated above substantially influenced rice yield per hectare.

The analysis of resource productivity was made to test the hypotheses that agricultural resources are being utilized inefficiently. The Cobb-Douglas type of production function was used to determine the resource productivity. The concept of optimality was used as a criterion to test the efficiency of the use of resources.

In the final section the possibility for increasing rice productivity under the existing resources was determined by the technique of partial budgeting.

The surveys have shown that farms with good irrigation, as in Calamba, received higher farm incomes than farms in the other two areas. This was due to the fact that farms with good irrigation produced relatively higher yields than poorly irrigated farms. The adoption of new varieties with adequate and other inputs can also bring about higher rice yield.

The results of the resource productivity analysis suggest that there is little potential for increasing rice productivity under the present technology. However, there exists a potential for achieving higher rice productivity through adoption of improved practices and adjustment in the use of some resources.

To encourage the adoption of improved practices such as use of better seeds and fertilizers, policy makers should direct their policies at reducing risk and uncertainty through better supporting services, credit and marketing facilities, while waiting for the improvement of irrigation facilities.

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APPENDIX A

RICE VARIETIES PLANTED IN THREE AREAS OF LAGUNA, PHILIPPINES, BY VARIETY, BY LOCATION, AND BY YEAR, WET SEASON 1966-71

Location	1966	1967	1968	1969	1970	1971
	Per cent of farms reporting					
1. Biñan						
Local variety						
Malagkit sungsong[a]		1	11	3		
Intan	2	2		16		
Thailand (Binato)		20				
Wagwag	77	13				
Raminad	21	2				
Tjere-mas						
Other local varieties		13		1		
New variety						
BPI-76		4	2			
IR 8		42	83	50	51	27
IR 5			4	1		
C4-63				23	43	16
IR-Malagkit[b]						
IR 20					2	6
IR 22					2	40
Other new varieties				6	2	11
Total	100 (47)	100 (54)	100 (47)	100 (74)	100 (55)	100 (63)
2. Cabuyao						
Local variety						
Malagkit sungsong	33	30	31	29	18	7
Intan	9			2		
Thailand (Binato)	9	7			1	
Wagwag	42	3				
Raminad						
Tjere-mas						
Other local varieties		1		1	1	
New Variety						
BP-76	7	3				
IR 8		56	62	48	48	36
IR 5			3	1	1	
C4-63			4	14	17	17
IR-Malagkit				5	9	27
IR 20					4	
IR 22					1	12
Other new varieties						1
Total	100 (55)	100 (75)	100 (65)	100 (84)	100 (85)	100 (104)

Appendix A, continued

Location	1966	1967	1968	1969	1970	1971
	Per cent of farms reporting					
3. Calamba						
Local variety						
Malagkit sungsong	91	37	38	37	17	9
Intan	4	10	3	1	1	
Thailand (Binato)	1	1				
Wagwag					1	
Raminad						
Tjere-mas						
Other local varieties			1			
New variety						
BPI-76	4	1				
IR 8		51	46	40	44	48
IR 5				1	2	3
C4-63			11	17	9	9
IR-Malagkit						1
IR 20					20	3
IR 22					3	23
Other new varieties			1	4	3	4
Total	100 (55)	100 (79)	100 (97)	100 (76)	100 (96)	100 (69)

Notes: a. Glutinous local variety.

b. Glutinous new variety.

Figures in parentheses are number of farms reporting.

APPENDIX B

RICE VARIETIES PLANTED IN THREE AREAS OF LAGUNA, PHILIPPINES, BY VARIETY, BY LOCATION, AND BY YEAR, DRY SEASON, 1967-71

Location	1967	1968	1969	1970	1971
	Per cent of farms reporting				
1. Biñan					
Local variety					
Malagkit sungsong[a]		2		6	7
Intan	8	11	7	6	2
Thailand (Binato)	22	18			
Wagwag	57	7			2
Raminad	5				
Tjere-mas		2			
Other local varieties	3				
New variety					
BPI-76					
IR 8	5	58	86	60	50
IR 5				11	
C4-63		2	7	11	12
IR-Malagkit[b]					2
IR 20				6	5
IR 22					13
Other new varieties					7
Total	100 (36)	100 (41)	100 (14)	100 (14)	100 (37)
2. Cabuyao					
Local variety					
Malagkit sungsong	6	14	13	8	4
Intan	42	18	30	28	5
Thailand (Binato)	12	9			
Wagwag	40	2	10	4	3
Raminad					
Tjere-mas					
Other local varieties					
New variety					
BPI-76					
IR 8		57	43	42	32
IR 5				2	
C4-63			4	7	20
IR-Malagkit				2	18
IR 20				7	7
IR 22					7
Other new varieties					4
Total	100 (50)	100 (46)	100 (36)	100 (41)	100 (47)

Appendix B, continued

Location	1967	1968	1969	1970	1971
	Per cent of farms reporting				
3. Calamba					
Local variety					
Malagkit sungsong	5	25	19	14	10
Intan	85	68	27	4	6
Thailand (Binato)	8	7			
Wagwag					
Raminad					
Tjere-mas					
Other local varieties	2				
New variety					
BPI-76					
IR 8			39	62	48
IR 5			3	3	2
C4-63			11	9	8
IR-Malagkit					
IR 20				8	8
IR 22			1		14
Other new varieties					4
Total	100 (54)	100 (53)	100 (51)	100 (55)	100 (57)

Notes: a. Glutinous local variety.

b. Glutinous new variety.

Figures in parentheses are number of farms reporting.

APPENDIX C

PER CENT OF FARMS REPORTING BY TYPE OF FARM LABOUR AND BY FARM PRACTICE IN THREE AREAS, LAGUNA, PHILIPPINES, WET SEASON, 1970

Items	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
1. Seedbed preparation and care			
Hired	39.8	2.4	2.0
Family	12.0	15.9	26.7
Exchange	0.4	5.1	3.4
Operator	47.8	76.0	67.9
Sub-total	100.0	100.0	100.0
2. Plowing			
Hired	36.0	34.8	36.3
Family	29.7	26.3	23.6
Exchange	0.3	4.6	3.3
Operator	34.0	34.3	36.8
Sub-total	100.0	100.0	100.0
3. Harrowing			
Hired	29.0	38.2	38.9
Family	25.6	28.1	19.1
Exchange	3.2	6.1	6.3
Operator	42.2	27.6	35.7
Sub-total	100.0	100.0	100.0
4. Repair and cleaning of dikes			
Hired	16.7	19.2	19.1
Family	28.6	34.8	32.4
Exchange	0.0	0.0	0.2
Operator	54.7	46.0	48.3
Sub-total	100.0	100.0	100.0
5. Rolling and distributing of seedlings			
Hired	80.0	71.7	76.4
Family	4.0	7.5	3.6
Exchange	2.0	0.0	1.8
Operator	14.0	20.8	18.2
Sub-total	100.0	100.0	100.0
6. Transplanting			
Hired	97.6	100.0	99.4
Family	0.0	0.0	0.0
Exchange	0.0	0.0	0.0
Operator	2.4	0.0	0.6
Sub-total	100.0	100.0	100.0

Appendix C, continued

Items	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
7. Replanting			
Hired	39.2	19.7	20.9
Family	37.5	36.9	37.4
Exchange	0.0	0.6	0.2
Operator	23.3	42.8	41.5
Sub-total	100.0	100.0	100.0
8. Weeding			
Hired	38.6	53.8	47.5
Family	49.0	19.9	29.8
Exchange	0.1	0.8	1.6
Operator	12.3	25.5	21.1
Sub-total	100.0	100.0	100.0
9. Chemical application			
Hired	2.8	13.0	6.8
Family	16.5	27.3	21.3
Exchange	8.2	1.3	4.5
Operator	72.5	58.4	67.4
Sub-total	100.0	100.0	100.0
10. Fertilizing			
Hired	12.5	17.0	8.9
Family	11.3	35.8	17.7
Exchange	2.5	1.9	3.8
Operator	73.7	45.3	69.6
Sub-total	100.0	100.0	100.0
11. Harvesting, threshing, winnowing and hauling of threshed (unmilled) rice			
Hired	98.6	95.9	94.2
Family	0.6	1.5	1.1
Exchange	0.0	1.6	2.9
Operator	0.8	1.0	1.8
Sub-total	100.0	100.0	100.0
12. All farm practices	(41)	(59)	(55)
Hired	66.1	68.0	65.7
Family	19.0	12.9	14.0
Exchange	0.4	1.7	2.2
Operator	14.5	17.4	18.1
Total	100.0	100.0	100.0

Note: Figures in parentheses are number of farms reporting.

APPENDIX D

PER CENT OF FARMS REPORTING BY TYPE OF FARM LABOUR AND BY FARM PRACTICE IN THREE AREAS, LAGUNA, PHILIPPINES, DRY SEASON, 1970

Items	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
1. Seedbed preparation and care			
Hired	14.7	4.1	0.0
Family	33.7	23.1	19.5
Exchange	0.7	6.3	2.0
Operator	50.7	66.5	78.5
Sub-total	100.0	100.0	100.0
2. Plowing			
Hired	30.4	46.4	34.9
Family	26.0	20.7	16.8
Exchange	0.0	5.4	4.4
Operator	43.6	27.5	43.9
Sub-total	100.0	100.0	100.0
3. Harrowing			
Hired	54.5	46.6	42.1
Family	14.0	19.6	9.8
Exchange	1.7	0.9	4.0
Operator	29.8	32.9	44.1
Sub-total	100.0	100.0	100.0
4. Repair and cleaning of dikes			
Hired	10.6	19.3	20.2
Family	26.2	34.7	28.0
Exchange	9.7	0.0	3.4
Operator	53.5	46.0	48.4
Sub-total	100.0	100.0	100.0
5. Rolling and distributing of seedlings			
Hired	69.5	70.2	77.8
Family	6.8	5.3	5.6
Exchange	3.4	1.8	1.9
Operator	20.3	22.7	14.7
Sub-total	100.0	100.0	100.0
6. Transplanting			
Hired	100.0	100.0	100.0
Family	0.0	0.0	0.0
Exchange	0.0	0.0	0.0
Operator	0.0	0.0	0.0
Sub-total	100.0	100.0	100.0

Appendix D, continued

Items	Location		
	Biñan	Cabuyao	Calamba
	(%)	(%)	(%)
7. Replanting			
Hired	18.0	27.3	14.2
Family	57.4	34.5	29.2
Exchange	2.2	0.0	5.9
Operator	22.4	38.2	50.7
Sub-total	100.0	100.0	100.0
8. Weeding			
Hired	64.4	67.2	43.0
Family	19.6	16.5	25.6
Exchange	0.0	0.0	5.2
Operator	16.0	16.3	26.2
Sub-total	100.0	100.0	100.0
9. Chemical application			
Hired	5.1	16.7	0.0
Family	27.6	18.2	24.7
Exchange	5.1	4.5	0.0
Operator	62.2	60.6	75.3
Sub-total	100.0	100.0	100.0
10. Fertilizing			
Hired	0.0	3.0	1.0
Family	31.4	19.8	12.3
Exchange	0.0	1.0	1.0
Operator	68.6	76.2	85.7
Sub-total	100.0	100.0	100.0
11. Harvesting, threshing, winnowing and hauling of threshed (unmilled) rice			
Hired	100.0	100.0	100.0
Family	0.0	0.0	0.0
Exchange	0.0	0.0	0.0
Operator	0.0	0.0	0.0
Sub-total	100.0	100.0	100.0
12. All farm practices			
Hired	69.8	70.9	71.5
Family	13.4	11.8	9.3
Exchange	1.1	0.7	1.9
Operator	15.7	16.6	17.3
Total	100.0	100.0	100.0

APPENDIX E

ESTIMATED RICE YIELD (CAVAN/HA) WITH VARYING LABOUR DAYS (X_1), HOLDING OTHER VARIABLES AT THEIR ARITHMETIC MEANS, BY SEASON AND BY LOCATION, LAGUNA, PHILIPPINES, 1970

	Biñan		Cabuyao		Calamba	
Pre-harvest labour	Wet[1]	Dry[2]	Wet[3]	Dry[4]	Wet[5]	Wet[6]
(man/days/ha)						
20	47.4	22.5	65.6	58.5	91.8	92.9
40	51.3	12.8	64.4	60.7	94.0	99.5
60	53.6	9.0	63.8	61.8	95.5	103.8
80	55.3	7.0	63.3	62.8	96.4	106.7
100	56.8	6.0	63.0	63.4	97.1	109.4
120	57.9	5.0	62.7	64.0	97.7	111.2

Estimates based on:

1. $\log \hat{Y}c = - 8.50427 + 0.27548\ a_2 + 0.11105 \log X_1 + 0.01163 \log X_2 + 0.35377 \log \bar{X}_3 - 0.26174 \log \bar{X}_4 + 1.26198 \log \bar{X}_5$

2. $\log \hat{Y}c = 10.39501 + 0.26521\ a_2 - 0.81760 \log X_1, + 0.75336 \log \bar{X}_2 - 1.66261 \log \bar{X}_3 + 0.38463 \log \bar{X}_4 - 0.04514 \log \bar{X}_5$

3. $\log \hat{Y}c = - 0.61129 + 0.05683\ a_1 + 0.29578\ a_2 - 0.02552 \log X_1 + 0.04699 \log \bar{X}_2 + 0.26284 \log \bar{X}_3 + 0.03006 \log \bar{X}_4 + 0.30001 \log \bar{X}_5$

4. $\log \hat{Y}c = - 3.99681 + 0.10595\ a_1 + 2.10509\ a_2 + 0.05102 \log X_1 + 0.23266 \log \bar{X}_2 - 0.13363 \log \bar{X}_3 + 0.12896 \log \bar{X}_4 + 0.48470 \log \bar{X}_5$

5. $\log \hat{Y}c = 4.06723 + 0.08728\ a_1 + 0.33522\ a_2 + 0.03449 \log X_1 + 0.14415 \log \bar{X}_2 + 0.34642 \log \bar{X}_3 - 0.35636 \log \bar{X}_4 + 0.02808 \log \bar{X}_5$

6. $\log \hat{Y}c = 5.42229 + 0.13277\ a_1 + 0.2868\ a_2 + 0.09947 \log X_1 + 0.0893 \log \bar{X}_2 + 0.09707 \log \bar{X}_3 + 0.22159 \log \bar{X}_4 - 0.36854 \log \bar{X}_5$

APPENDIX F

ESTIMATED RICE YIELD (CAVAN/HA) WITH VARYING LEVEL OF ELEMENTAL NITROGEN (X_2), HOLDING OTHER VARIABLES AT THEIR ARITHMETIC MEANS, BY SEASON, AND BY LOCATION, LAGUNA, PHILIPPINES, 1970

	Biñan		Cabuyao		Calamba	
Elemental Nitrogen	Wet[1]	Dry[2]	Wet[3]	Dry[4]	Wet[5]	Dry[6]
(kg/ha)						
30	53.6	7.9	61.9	50.5	87.3	95.5
50	54.0	11.6	63.3	57.0	93.8	99.8
70	54.2	14.9	64.6	61.7	98.4	102.8
90	54.3	18.0	65.3	65.3	102.1	105.2
120	54.5	22.5	66.1	69.8	104.0	107.9

Estimates based on:

1. $\log \hat{Y}c = -8.50427 + 0.27548\, a_2 + 0.11105 \log \bar{X}_1 + 0.01163 \log X_2 + 0.35377 \log \bar{X}_3 - 0.26174 \log \bar{X}_4 + 1.26198 \log \bar{X}_5$

2. $\log \hat{Y}c = 10.39501 + 0.26521\, a_2 - 0.81760 \log \bar{X}_1 + 0.75336 \log X_2 - 1.66261 \log \bar{X}_3 + 0.38463 \log \bar{X}_4 - 0.04514 \log \bar{X}_5$

3. $\log \hat{Y}c = -0.61129 + 0.05683\, a_1 + 0.29578\, a_2 - 0.02552 \log \bar{X}_1 + 0.04699 \log X_2 + 0.26284 \log \bar{X}_3 + 0.03006 \log \bar{X}_4 + 0.30001 \log \bar{X}_5$

4. $\log \hat{Y}c = -3.99681 + 0.10595\, a_1 + 2.10509\, a_2 + 0.050102 \log \bar{X}_1 + 0.23266 \log X_2 - 0.13363 \log \bar{X}_3 + 0.12896 \log \bar{X}_4 + 0.48470 \log \bar{X}_5$

5. $\log \hat{Y}c = 4.06723 + 0.08728\, a_1 + 0.33522\, a_2 + 0.03449 \log \bar{X}_1 + 0.14415 \log X_2 + 0.34642 \log \bar{X}_3 - 0.35636 \log \bar{X}_4 + 0.02808 \log \bar{X}_5$

6. $\log \hat{Y}c = 5.42229 + 0.13277\, a_1 + 0.2868\, a_2 + 0.09947 \log \bar{X}_1 + 0.0893 \log X_2 + 0.09707 \log \bar{X}_3 + 0.22159 \log \bar{X}_4 - 0.36854 \log \bar{X}_5$

APPENDIX G

ESTIMATED RICE YIELD (CAVAN/HA) WITH VARYING LEVEL OF OPERATING COSTS (X_3), HOLDING OTHER VARIABLES AT THEIR ARITHMETIC MEANS, BY SEASON AND BY LOCATION, LAGUNA, PHILIPPINES, 1970

Operating costs	Biñan		Cabuyao		Calamba	
	Wet[1]	Dry[2]	Wet[3]	Dry[4]	Wet[5]	Dry[6]
(pesos/ha)						
100	50.0	67.3	56.9	66.2	97.5	102.1
300	73.8	10.8	75.9	57.2	142.9	113.8
500	88.5	4.6	86.9	53.3	170.2	119.4
700	99.5	2.6	94.8	50.9	191.0	123.3
900	108.6	1.7	101.2	49.3	208.9	126.5

Estimates based on:

1. $\log \hat{Y}c = - 8.50427 + 0.27548\ a_2 + 0.11105 \log \bar{X}_1 + 0.01163 \log \bar{X}_2 + 0.35377 \log X_3 - 0.26174 \log \bar{X}_4 + 1.26198 \log \bar{X}_5$

2. $\log \hat{Y}c = 10.39501 + 0.26521\ a_2 - 0.81760 \log \bar{X}_1 + 0.75336 \log \bar{X}_2 - 1.66261 \log X_3 + 0.38643 \log \bar{X}_4 - 0.04514 \log \bar{X}_5$

3. $\log \hat{Y}c = - 0.61129 + 0.05683\ a_1 + 0.29578\ a_2 - 0.02552 \log \bar{X}_1 + 0.04699 \log \bar{X}_2 + 0.26284 \log X_3 + 0.03006 \log \bar{X}_4 + 0.3001 \log \bar{X}_5$

4. $\log \hat{Y}c = - 3.99681 + 0.10595\ a_1 + 2.10509\ a_2 + 0.050102 \log \bar{X}_1 + 0.23266 \log \bar{X}_2 - 0.\ 13363 \log X_3 + 0.12896 \log \bar{X}_4 + 0.48470 \log \bar{X}_5$

5. $\log \hat{Y}c = 4.06723 + 0.08728\ a_1 + 0.33522\ a_2 + 0.03449 \log \bar{X}_1 + 0.14415 \log \bar{X}_2 + 0.34642 \log X_3 - 0.35636 \log \bar{X}_4 + 0.02808 \log \bar{X}_5$

6. $\log \hat{Y}c = 5.4229 + 0.13277\ a_1 + 0.2868\ a_2 + 0.09947 \log \bar{X}_1 + 0.0893 \log \bar{X}_2 + 0.09707 \log \bar{X}_3 + 0.22159 \log \bar{X}_4 - 0.36854 \log \bar{X}_5$

APPENDIX H

ESTIMATED RICE YIELD (CAVAN/HA) WITH VARYING LEVEL OF RAINFALL (X_4), HOLDING OTHER VARIABLES AT THEIR ARITHMETIC MEANS, BY SEASON AND BY LOCATION, LAGUNA, PHILIPPINES, 1970

	Biñan		Cabuyao		Calamba	
Rainfall	Wet[1]	Dry[2]	Wet[3]	Dry[4]	Wet[5]	Dry[6]
(millimeters)						
500	63.0	13.6	62.4	57.0	121.9	119.4
900	54.1	17.0	63.5	65.0	98.0	135.8
1300	49.1	19.6	64.1	71.0	86.7	147.6
1500	47.3	20.7	64.6	75.0	82.4	152.1

Estimates based on:

1. $\log Yc = -8.50427 + 0.27548\, a_2 + 0.11105 \log \bar{X}_1 + 0.01163 \log \bar{X}_2 + 0.35377 \log \bar{X}_3 - 0.26174 \log X_4 + 1.26198 \log \bar{X}_5$

2. $\log Yc = 10.39501 + 0.26521\, a_2 - 0.81760 \log \bar{X}_1 + 0.75336 \log \bar{X}_2 - 1.66261 \log \bar{X}_3 + 0.38463 + 0.38463 \log X_4 - 0.04514 \log \bar{X}_5$

3. $\log Yc = -0.61129 + 0.05683\, a_1 + 0.29578\, a_2 - 0.02552 \log \bar{X}_1 + 0.04699 \log \bar{X}_2 + 0.26284 \log \bar{X}_3 + 0.03006 \log X_4 + 0.30001 \log \bar{X}_5$

4. $\log Yc = -3.99681 + 0.10595\, a_1 + 2.10509\, a_2 + 0.050102 \log \bar{X}_1 + 0.23266 \log \bar{X}_2 - 0.13363 \log \bar{X}_3 + 0.12896 \log \bar{X}_4 + 0.48470 \log \bar{X}_5$

5. $\log Yc = 4.06723 + 0.08728\, a_1 + 0.33522\, a_2 + 0.03449 \log \bar{X}_1 + 0.14415 \log \bar{X}_2 + 0.34642 \log \bar{X}_3 - 0.35636 \log \bar{X}_4 + 0.02808 \log \bar{X}_5$

6. $\log Yc = 5.4229 + 0.13277\, a_1 + 0.2868\, a_2 + 0.09947 \log \bar{X}_1 + 0.0893 \log \bar{X}_2 + 0.09707 \log \bar{X}_3 + 0.22159 \log X_4 - 0.36854 \log \bar{X}_5$

APPENDIX I

ESTIMATED RICE YIELD (CAVAN/HA) WITH VARYING LEVEL OF SOLAR ENERGY (X_5), HOLDING OTHER VARIABLES AT THEIR ARITHMETIC MEANS, BY SEASON AND BY LOCATION, LAGUNA, PHILIPPINES, 1970

	Biñan		Cabuyao		Calamba	
Solar Energy	Wet	Dry	Wet	Dry	Wet	Dry
(gm- cal/cm^2) 45 days before harvest						
8000	24.4	11.3	53.5	41.6	94.4	140.0
12000	40.6	11.1	60.3	45.4	94.6	121.0
14000	49.3	11.0	63.1	48.9	94.8	115.0
16000	58.5	11.0	65.6	52.1	95.3	109.0
18000	67.9	10.9	68.1	55.2	95.5	104.0
22000	87.5	10.8	72.3	60.8	95.9	96.7
24000	97.5	10.8	74.3	63.5	96.2	93.7

Estimates based on:

1. $\log Yc = -8.50427 + 0.27548\, a_2 + 0.11105 \log \bar{X}_1 + 0.01163 \log \bar{X}_2 + 0.35377 \log \bar{X}_3 - 0.26174 \log \bar{X}_4 + 1.26198 \log X_5$

2. $\log Yc = 10.39501 + 0.26521\, a_2 - 0.81760 \log \bar{X}_1 + 0.75336 \log \bar{X}_2 - 1.66261 \log \bar{X}_3 + 0.38463 \log \bar{X}_4 - 0.04514 \log X_5$

3. $\log Yc = -0.61129 + 0.05683\, a_1 + 0.29578\, a_2 - 0.02552 \log \bar{X}_1 + 0.04699 \log \bar{X}_2 + 0.26284 \log \bar{X}_3 + 0.03006 \log \bar{X}_4 + 0.30001 \log X_5$

4. $\log Yc = -3.99681 + 0.10595\, a_1 + 2.10509\, a_2 + 0.050102 \log \bar{X}_1 + 0.23266 \log \bar{X}_2 - 0.13363 \log \bar{X}_3 + 0.12896 \log \bar{X}_4 + 0.48470 \log X_5$

5. $\log Yc = 4.06723 + 0.08728\, a_1 + 0.33522\, a_2 + 0.03449 \log \bar{X}_1 + 0.14415 \log \bar{X}_2 + 0.34642 \log \bar{X}_3 - 0.35636 \log \bar{X}_4 + 0.02808 \log X_5$

6. $\log Yc = 5.4229 + 0.13277\, a_1 + 0.2868\, a_2 + 0.09947 \log \bar{X}_1 + 0.0893 \log \bar{X}_2 + 0.09707 \log \bar{X}_3 + 0.22159 \log \bar{X}_4 - 0.36854 \log \bar{X}_5$

APPENDIX J

The International Rice Research Institute
Agricultural Economics Department
Los Baños, Laguna

Name of Farmer ________________ Date ________________

Location ________________ Enumerator ________________

LAGUNA SURVEY (DRY SEASON)*

I. BASIC INFORMATION FOR ALL CARDS

1. Record Number 101 (A-1) to 721 (G-21) — _1 _2 _3

   1 = A = Platero, Biñan
   2 = B = San Antonio, Biñan
   3 = C = Sala, Cabuyao
   4 = D = Bigaa, Cabuyao
   5 = E = Niugan, Cabuyao
   6 = F = Parain, Calamba
   7 = G = Real, Calamba

2. Card Number
   (No. of cards per farm = 3) — _4

3. Season — _5

   1 = Wet 2 = Dry

4. Year
   (Corresponding to season 1969 = 69) — _6 _7

5. Total farm hectarage (nearest 10th) — _8 _9 _10

6. Total hectarage planted to rice (nearest 10th) — _11 _12 _13

7. Irrigation — _14

   1 = Rainfed
   2 = 1 crop gravity
   3 = 2 crops gravity
   4 = 3 crops gravity/2 yrs
   5 = 4 crops gravity/3 yrs
   6 = 1 crop pump
   7 = 2 crops pump
   8 = others (specify)

* The same format was used for the Wet Season Survey.

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8. Tenancy — $\overline{15}$

1 = Owner-operator
2 = Tenant
3 = Leasehold
4 = Part-owner
5 = others (specify)

II. CROP INFORMATION (Card I)

9. Dry season - HYV — $\overline{16}$

1. IR8	5. IRRI-Malagkit
2. IR5	6. IR20
3. C4-63	7. IR22
4. BPI-76	8. Others (specify)

10. Dry season - HYV I Hectarage (nearest 10th) — $\overline{17}$ $\overline{18}$ $\overline{19}$

11. Dry season - HYV I Date of planting — $\overline{20}$ $\overline{21}$

01 = 1st wk Nov	09 = 1st wk Jan
02 = 2nd wk Nov	10 = wnd wk Jan
03 = 3rd wk Nov	11 = 3rd wk Jan
04 = 4th wk Nov	12 = 4th wk Jan
05 = 1st wk Dec	13 = 1st wk Feb
06 = 2nd wk Dec	14 = 2nd wk Feb
07 = 3rd wk Dec	15 = 3rd wk Feb
08 = 4th wk Dec	16 = 4th wk Feb
	17 = others (specify)

12. Dry season - HYV I Date of Harvest — $\overline{22}$ $\overline{23}$

01 = 1st wk Feb	09 = 1st wk Apr
02 = 2nd wk Feb	10 = 2nd wk Apr
03 = 3rd wk Feb	11 = 3rd wk Apr
04 = 4th wk Feb	12 = 4th wk Apr
05 = 1st wk Mar	13 = 1st wk May
06 = 2nd wk Mar	14 = 2nd wk May
07 = 3rd wk Mar	15 = 3rd wk May
08 = 4th wk Mar	16 = 4th wk May
	17 = others (specify)

13. Dry season - HYV I Yield/ha (nearest cavan) — $\overline{24}$ $\overline{25}$ $\overline{26}$

14. Dry season - HYV I Price/cavan (nearest 10th of peso) — $\overline{27}$ $\overline{28}$ $\overline{29}$

15. Dry season - HYV II 30

1. IR8	5. IRRI-Malagkit
2. IR5	6. IR20
3. C4-63	7. IR22
4. BPI-76	8. others (specify)

16. Dry season - HYV II Hectarage (nearest 10th) 31 31 33

17. Dry season - HYV II Date of planting 34 35

01 = 1st wk Nov	09 - 1st wk Jan
02 = 2nd wk Nov	10 = 2nd wk Jan
03 = 3rd wk Nov	11 = 3rd wk Jan
04 = 4th wk Nov	12 = 4th wk Jan
05 = 1st wk Dec	13 = 1st wk Feb
06 = 2nd wk Dec	14 = 2nd wk Feb
07 = 3rd wk Dec	15 = 3rd wk Feb
08 = 4th wk Dec	16 = 4th wk Feb
	17 = others (specify)

18. Dry season - HYV II Date of harvest 36 37

01 = 1st wk Feb	09 = 1st wk Apr
02 = 2nd wk Feb	10 = 2nd wk Apr
03 = 3rd wk Feb	11 = 3rd wk Apr
04 = 4th wk Feb	12 = 4th wk Apr
05 = 1st wk Mar	13 = 1st wk May
06 = 2nd wk Mar	14 = 2nd wk May
07 = 3rd wk Mar	15 = 3rd wk May
08 = 4th wk Mar	16 = 4th wk May
	17 = others (specify)

19. Dry season - HYV II Yield/ha (nearest cavan) 38 39 40

20. Dry season - HYV II Price/cavan (nearest 10th of peso) 41 42 43

21. Dry season - HYV III 44

1. IR8	5. IRRI-Malagkit
2. IR5	6. IR20
3. C4-63	7. IR22
4. BPI-76	8. others (specify)

22. Dry season - HYV III Hectarage (nearest 10th) 45 46 47

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23. Dry season - HYV III Date of planting 48 49

01 = 1st wk Nov	09 = 1st wk Jan
02 = 2nd wk Nov	10 = 2nd wk Jan
03 = 3rd wk Nov	11 = 3rd wk Jan
04 = 4th wk Nov	12 = 4th wk Jan
05 = 1st wk Dec	13 = 1st wk Feb
06 = 2nd wk Dec	14 = 2nd wk Feb
07 = 3rd wk Dec	15 = 3rd wk Feb
08 = 4th wk Dec	16 = 4th wk Feb
	17 = others (specify)

24. Dry season - HYV III Date of harvest 50 51

01 = 1st wk Feb	09 = 1st wk Apr
02 = 2nd wk Feb	10 = 2nd wk Apr
03 = 3rd wk Feb	11 = 3rd wk Apr
04 = 4th wk Feb	12 = 4th wk Apr
05 = 1st wk Mar	13 = 1st wk May
06 = 2nd wk Mar	14 = 2nd wk May
07 = 3rd wk Mar	15 = 3rd wk May
08 = 4th wk Mar	16 = 4th wk May
	17 = others (specify)

25. Dry season - HYV III Yield/ha (nearest cavan) 52 53 54

26. Dry season - HYV III Price/cavan (nearest 10th of peso) 55 56 57

27. Dry season - Local I 58

1. Intan	5. Raminad
2. Malagkit Sungsong	6. Tjeremas
3. Thailand (Binato)	7. others (specify)
4. Wagwag	

28. Dry season - Local I Hectarage (nearest 10th) 59 60 61

29. Dry season - Local I Date of planting 62 63

01 = 1st wk Nov	09 = 1st wk Jan
02 = 2nd wk Nov	10 = 2nd wk Jan
03 = 3rd wk Nov	11 = 3rd wk Jan
04 = 4th wk Nov	12 = 4th wk Jan
05 = 1st wk Dec	13 = 1st wk Feb
06 = 2nd wk Dec	14 = 2nd wk Feb
07 = 3rd wk Dec	15 = 3rd wk Feb
08 = 4th wk Dec	16 = 4th wk Feb
	17 = others (specify)

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30. Dry season - Local I Date of harvest $\overline{64}$ $\overline{65}$

01 = 1st wk Feb	09 = 1st wk Apr
02 = 2nd wk Feb	10 = 2nd wk Apr
03 = 3rd wk Feb	11 = 3rd wk Apr
04 = 4th wk Feb	12 = 4th wk Apr
05 = 1st wk Mar	13 = 1st wk May
06 = 2nd wk Mar	14 = 2nd wk May
07 = 3rd wk Mar	15 = 3rd wk May
08 = 4th wk Mar	16 = 4th wk May
	17 = others (specify)

31. Dry season - Local I Yield/ha (nearest cavan) $\overline{66}$ $\overline{67}$ $\overline{68}$

32. Dry season - Local I Price/cavan (nearest 10th of peso) $\overline{69}$ $\overline{70}$ $\overline{71}$

9. Dry season - Local II (Card II) $\overline{16}$

1. Intan	5. Raminad
2. Malagkit Sungsong	6. Tjeremas
3. Thailand (Binato)	7. others (specify)
4. Wagwag	

10. Dry season - Local II Hectarage (nearest 10th) $\overline{17}$ $\overline{18}$ $\overline{19}$

11. Dry season - Local II Date of planting $\overline{20}$ $\overline{21}$

01 = 1st wk Nov	09 = 1st wk Jan
02 = 2nd wk Nov	10 = 2nd wk Jan
03 = 3rd wk Nov	11 = 3rd wk Jan
04 = 4th wk Nov	12 = 4th wk Jan
05 = 1st wk Dec	13 = 1st wk Feb
06 = 2nd wk Dec	14 = 2nd wk Feb
07 = 3rd wk Dec	15 = 3rd wk Feb
08 = 4th wk Dec	16 = 4th wk Feb
	17 = others (specify)

12. Dry season - Local II Date of harvest $\overline{22}$ $\overline{23}$

01 = 1st wk Feb	09 = 1st wk Apr
02 = 2nd wk Feb	10 = wnd wk Apr
03 = 3rd wk Feb	11 = 3rd wk Apr
04 = 4th wk Feb	12 = 4th wk Apr
05 = 1st wk Mar	13 = 1st wk May
06 = 2nd wk Mar	14 = 2nd wk May
07 = 3rd wk Mar	15 = 3rd wk May
08 = 4th wk Mar	16 = 4th wk May
	17 = others (specify)

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13. Dry season - Local II Yield/ha (nearest cavan) — 24 25 26

14. Dry season - Local II Price/cavan (nearest 10th of peso) — 27 28 29

15. Dry season - Local III — 30

1. Intan	5. Raminad
2. Malagkit Sungsong	6. Tjermas
3. Thailand (Binato)	7. others (specify)

16. Dry season - Local III Hectarage (nearest 10th) — 31 32 33

17. Dry season - Local III Date of planting — 34 35

01 = 1st wk Nov	09 - 1st wk Jan
02 = 2nd wk Nov	10 = 2nd wk Jan
03 = 3rd wk Nov	11 = 3rd wk Jan
04 = 4th wk Nov	12 = 4th wk Jan
05 = 1st wk Dec	13 = 1st wk Feb
06 = 2nd wk Dec	14 = 2nd wk Feb
07 = 3rd wk Dec	15 = 3rd wk Feb
08 = 4th wk Dec	16 = 4th wk Feb
	17 = others (specify)

18. Dry season - Local III Date of harvest — 36 37

01 = 1st wk Feb	09 = 1st wk Apr
02 = 2nd wk Feb	10 = 2nd wk Apr
03 = 3rd wk Feb	11 = 3rd wk Apr
04 = 4th wk Feb	12 = 4th wk Apr
05 = 1st wk Mar	13 = 1st wk May
06 = 2nd wk Mar	14 = 2nd wk May
07 = 3rd wk Mar	15 = 3rd wk May
08 = 4th wk Mar	16 = 4th wk May
	17 = others (specify)

19. Dry season - Local III Yield/ha (nearest cavan) — 38 39 40

20. Dry season - Local III Price/cavan (nearest 10th of peso) — 41 42 43

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III. INFORMATION OF VARIABLE & FIXED COSTS (Card III)

9. Kind of fertilizer used this wet season — 16

   1. Am. Sulfate
   2. Urea
   3. Am. Phosphate
   4. Complete (specify)
   5. Comb. of diff. kind of fertilizers (specify)

10. Amount of fertilizer used this wet season

    Nitrogen/hectarage (nearest kg) — 17 18 19

    Percent of area fertilized (e.g. 50%) — 20 21 22

11. Value of fertilizer used this wet season
    Pesos/hectare (nearest peso) — 23 24 25

12. Method of fertilizer used this wet season — 26

    1. Basal application
    2. Top dress
    3. Basal and top dress

    Frequency of fertilizer application

    Basal 1 = once 2 = twice — 27

    Top dress 1 = once 2 = twice — 28

    Basal & top dress — 29

    1 = 1 basal, 1 top dress
    2 = 1 basal, 2 top dress
    3 = 2 basal, 1 top dress
    4 = 2 basal, 2 top dress
    5 = others (specify)

13. Value of insecticide used this wet season
    Pesos/hectare (nearest peso) — 30 31 32

    Percent area applied — 33 34 35

14. Kind of insecticide used this wet season — 36

	Kind
1. Granular	....
2. Liquid	....
3. Wettable	....

15. Time of insecticide application — 37

    1. Preventive
    2. Applied at time of attack

(NOTE: Enumerator also take the number of days after transplanting when insecticide was applied.)

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16. Value of weedicide used this wet season

    Pesos/hectare (nearest 10th of peso) ‾‾ 38 ‾‾ 39 ‾‾ 40

    Percent area applied by weedicide ‾‾ 41 ‾‾ 42 ‾‾ 43

17. Kind of weedicide used this wet season ‾‾ 44

    Kind

    1. Granular ....
    2. Liquid ....
    3. Wettable ....

18. Time of weedicide application ‾‾ 45

    1. Pre-emergence
    2. Post-emergence

(NOTE: Enumerator also take the number of days after transplanting when weedicide was applied.)

19. Value of seeds used this wet season

    Pesos/cavan (nearest peso) ‾‾ 46 ‾‾ 47

    Pesos/farm (nearest peso) ‾‾ 48 ‾‾ 49 ‾‾ 50

20. Value of seeds used last wet season

    Pesos/cavan (nearest peso) ‾‾ 51 ‾‾ 52

    Pesos/farm (nearest peso) ‾‾ 53 ‾‾ 54 ‾‾ 55

21. Irrigation expenses

    Pesos/hectare (nearest peso) ‾‾ 56 ‾‾ 57 ‾‾ 58

    (Note: If pump - (cost of fuel and oil)
    If gravity - (charge/season))

22. Land rent (for leashold only)

    Cavans/hectare (nearest cavan) ‾‾ 59 ‾‾ 60

    Pesos/hectare (nearest 10 pesos) ‾‾ 61 ‾‾ 62 ‾‾ 63

IV. INFORMATION ON LABOR INPUTS AND FARMING PRACTICES (Card IV)

9. Method of seeding used this wet season 16

1. Dapog
2. Wetbed
3. Broadcast

Labor used this wet season in seeding & seedbed preparation and care (nearest 10th manday/ha)

Hired labor 17 18

Family labor 19 20

Exchange 21 22

Operator 23 24

If hired or exchange, how much was spent (₱/ha) 25 26 27

10. Method of plowing 28

1. hand tractor 2. carabao 3. both

Labor used in plowing (mandays/ha)

Hired 29 30

Family 31 32

Exchange 33 34

Operator 35 36

If hired or exchange, how much was spent (₱/ha) 37 38 39

11. Method of harrowing 40

1. hand tractor 2. carabao 3. both

Labor used in harrowing (mandays/ha)

Hired 41 42

Family 43 44

Exchange 45 46

Operator 47 48

If hired or exchange, how much was spent (₱/ha) 49 50 51

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12. Labor used in repair and cleaning of dikes (mandays/ha)

Hired — 52 53

Family — 54 55

Exchange — 56 57

Operator — 58 59

If hired or exchange, how much was spent (₱/ha) — 60 61 62

13. Labor used in pulling and distributing of seedlings (wetbed) or carrying & distributing of dapog (nearest 10th of manday/ha

Hired — 63 64

Family — 65 66

Exchange — 67 68

Operator — 69 70

If hired or exchange, how much was spent (₱/ha) — 71 72

IVa. CONTINUATION OF INFORMATION ON LABOR INPUTS AND FARMING PRACTICES (Card V)

9. Transplanting method — 16

1. Straight row (both direction)
2. Straight row (one direction)
3. Ordinary

Cost of transplanting (₱/ha) — 17 18

Labour used in transplanting (mandays/ha) — 19 20

10. Replanting (mandays/ha)

Contracted — 21 22

Hired — 23 24

Family — 25 26

Exchange — 27 28

Operator — 29 30

If hired or exchange, how much was spent (₱/ha) — 31 32 33

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11. Weeding method ___ 34

1. Chemical only
2. Hand only
3. Rotary weeder only
4. Comb. of 1 & 2
5. Comb. of 1 & 3
6. Comb. of 2 & 3
7. Comb. of 1, 2 & 3

12. Labor used in weeding (mandays/ha)

Contracted (Gama) ___ 35 ___ 36 ___ 37

Hired ___ 38 ___ 39 ___ 40

Family ___ 41 ___ 42

Exchange ___ 43 ___ 44

Operator ___ 45 ___ 46

If hired or exchange, how much was spent (P//ha) ___ 47 ___ 48 ___ 49

13. Labor used in insecticide application (nearest 10th manday/ha)

Hired ___ 50 ___ 51

Family ___ 52 ___ 53

Exchange ___ 54 ___ 55

Operator ___ 56 ___ 57

If hired or exchange, how much was spent (₱/ha) ___ 58 ___ 59

14. Fertilizer application (nearest 10th of manday/ha)

Hired ___ 60 ___ 61

Family ___ 62 ___ 63

Exchange ___ 64 ___ 65

Operator ___ 66 ___ 67

If hired or exchange, how much was spent (P//ha) ___ 68 ___ 69

IVb.CONTINUATION OF INFORMATION ON LABOR INPUTS & FARMING PRACTICES (Card VI)

9. Mandays/ha used in harvesting and threshing

Hired		16 17
Family		18 19
Exchange		20 21
Operator		22 23
Harvester and thresher's share 1. 1/8 2. 3/8 3. others (specify)		24

10. Labor used in winnowing of palay (nearest 10th manday/ha)

Hired		25 26
Family		27 28
Exchange		29 30
Operator		31 32
If hired or exchange, how much was spent (₱/ha)		33 34

11. Labor used in hauling of threshed palay (nearest 10th manday/ha)

Hired		35 36 37
Family		38 39
Exchange		40 41
Operator		42 43
If hired or exchange, how much was spent (₱/ha)		44 45 46

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12. Sharing of farm expenses (for tenanted farm)

(1. landlord 2. tenant 3. both)

(1)	Land tax	47
(2)	Irrigation fee	48
(3)	Repair of pumps	49
(4)	Seedbed preparation and care	50
(5)	Land preparation	51
(6)	Repair and cleaning of dikes	52
(7)	Weeding	53
(8)	Chemicals	54
(9)	Fertilizers	55
(10)	Transplanting	56
(11)	Replanting	57
(12)	Harvesting & threshing	58
(13)	Winnowing	59
(14)	Hauling of threshed palay	60
(15)	Seeds	61
(16)	Food for hired & exchange labor	62